WAVETEK

8159 ENGINEER ROAD, SAN DIEGO, CALIFORNIA

Electronic Services Los Angeles
M166693X

INSTRUCTION MANUAL
MODEL 203
AND
MODEL 204
DIALAMATIC VOLTMETER

WAVETEK ®

8159 ENGINEER ROAD, SAN DIEGO, CALIFORNIA

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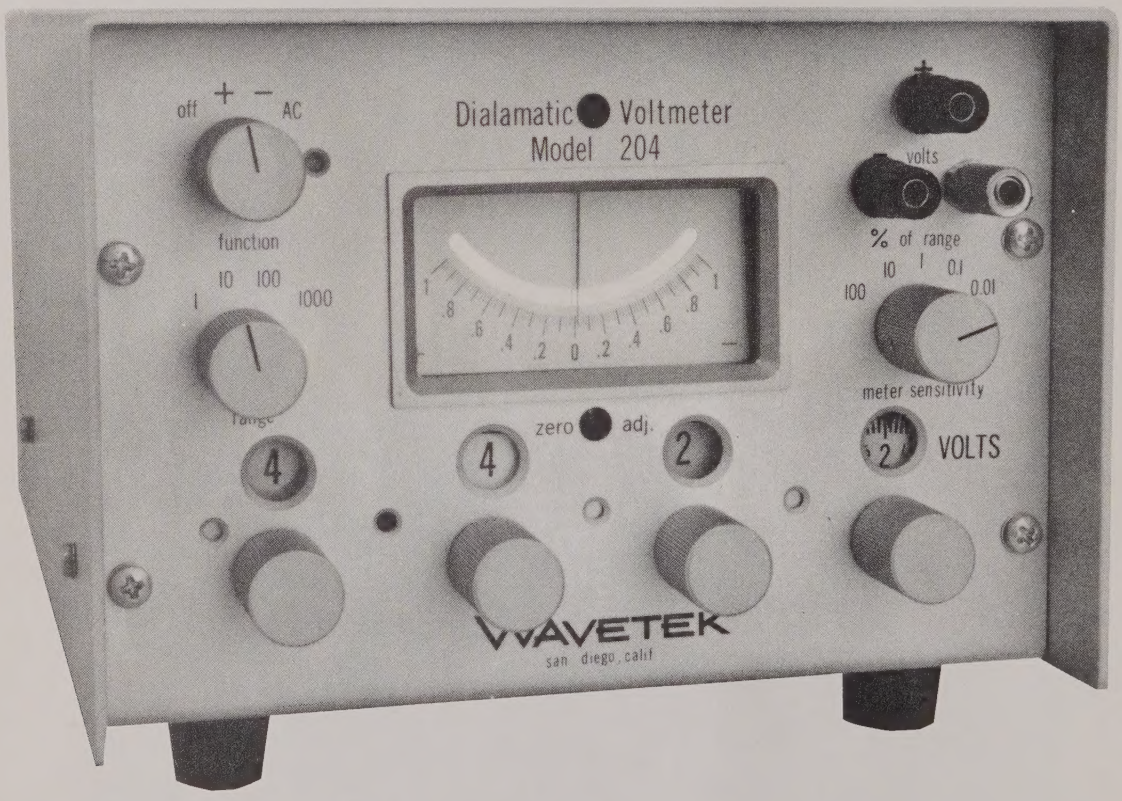

Dialamatic Voltmeter
Model 204
off
+
−
AC
function
1
10
100
1000
range
zero
adj.
4
4
2
volts
% of range
100
10
1
0.1
0.01
meter sensitivity
2
VOLTS
WAVETEK
san diego, calif

TABLE OF CONTENTS

Section		Page
I	GENERAL DESCRIPTION	
	Scope	1-A-1
	General	1-A-1
II	SPECIFICATIONS	
	General	2-A-1
	Voltmeter	2-A-2
III	OPERATING INSTRUCTIONS	
	Function of Controls	3-A-1
	General	3-B-3
	Direct Reading Voltmeter Operation	3-B-5
	AC Measurements	3-B-5
	Common Mode and Grounding Considerations	3-B-6
IV	THEORY OF OPERATION	
	General	4-A-1
	Input Attenuator	4-A-1
	Sensitivity Divider	4-A-3
	Input Filter and Limiter	4-A-3
	Precision Reference Supply	4-A-5
	Null Amplifier	4-A-5
	Feedback Network	4-A-6
	Direct Reading Voltmeter Mode	4-A-6
	Recorder Output	4-A-6
	AC Converter	4-A-6
V	MAINTENANCE	
	General	5-A-1
	Performance Check	5-A-1
	Power Supplies	5-A-3
	Null Amplifier	5-A-4-a
VI	CALIBRATION	
	Equipment Required	6-A-1-a
	Null Amplifier	6-A-1-a
	Range Calibration	6-A-2-a
	Direct Reading Voltmeter	6-A-5
	A-C Converter	6-B-1

Section Page

VII PARTS LIST

General. 7-A-1
Parts List Arrangement 7-A-1
List of Manufacturers 7-A-1
Matched or Paired Parts 7-A-2

VIII SCHEMATIC DIAGRAMS

LIST OF ILLUSTRATIONS

Figure No. Page

3-1 Common Mode Voltage Diagram 3-B-7
3-2 Diagram of Leakage Resistance from Power Supplies . . . 3-B-7

4-1 Differential Voltmeter Mode Block Diagram. 4-A-1
4-2 Differential Mode Block Diagram. 4-A-2
4-3 Reference Supply Block Diagram 4-A-5-a
4-4a Direct Reading Voltmeter Diagram. 4-A-7
4-B-1 A-C Converter Block Diagram. 4-B-8

6-1 Null Amplifier Board 6-A-3-a
6-2 Range Board. 6-A-6
6-3 A-C Converter Board. 6-B-2

7-1 Chassis Assembly 7-A-3-a
7-2 Range Board Assembly 7-B-1-b
7-3 A-C Converter Assembly 7-C-1
7-4 Null Amplifier Board Assembly 7-F-1-a
7-5 Power Supply Board Assembly. 7-G-1

WARRANTY

WAVETEK warrants instruments manufactured by it to have met WAVETEK's published specifications at the time of shipment of such instruments, and agrees to repair within one year of shipment, such instruments or their components (excluding batteries), which under normal use are found to be defective as a result of our manufacturing. Our obligation under this warranty is limited solely to repairing any such instrument which in our sole opinion proves to be defective when returned to our factory. Transportation to the factory is to be prepaid by purchaser. Instruments returned to the factory will be accepted only when prior authorization has been given by a representative of WAVETEK.

This warranty does not apply to any of our products which have been repaired or altered by persons not authorized by WAVETEK, or not in accordance with instructions furnished by us. If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at cost.

WAVETEK assumes no responsibility for its product being used in a hazardous or dangerous manner either alone or in conjunction with other equipment. WAVETEK assumes no liability for secondary charges or consequential damages, and in any event, WAVETEK's liability for breach of warranty under any contract or otherwise, shall not exceed the purchase price of the specific instrument shipped and as to which a claim is made.

Any recommendations made by WAVETEK for the use of its products are based upon tests believed to be reliable, but WAVETEK makes no warranty of the results to be obtained. This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for us any liability in connection with the sale of our products other than set forth herein.

SECTION I
GENERAL DESCRIPTION

SCOPE

This instruction manual provides information for operation, calibration, application and maintenance of WAVETEK DIALAMATIC Differential Voltmeters.

GENERAL

The WAVETEK DIALAMATIC Differential Voltmeters are precision voltage measuring instruments that measure d-c voltages. Some models measure both d-c and a-c voltages. The DIALAMATIC Differential Voltmeter is able to measure any signal that can be converted to a d-c voltage. All models are of all silicon design and some are available in battery powered "B" versions for complete isolation from the line. With the top cover removed, the glass-epoxy printed circuit boards swing out for easy troubleshooting and maintenance. These meters are intended for bench use for which a tilting bail is provided. Optional rack mounting hardware can be provided on special order.

Full scale voltage ranges are 1, 10, 100, and 1000 volts. The voltage measurement is read out on three ten position switches and a potentiometer which displays two digits. The switches and potentiometer have an interlocking gear train which provides automatic transfer by coupling the switch being adjusted with all the switches on the left. The transfer procedure also works identically in reverse, which is particularly useful in tracking a slowly drifting voltage. With a 5-digit readout, the WAVETEK TRANSFERMATIC switch resolution is one part in 100,000. An accurate 10-volt reference voltage is obtained from a matched pair of temperature compensated zener diodes. A Kelvin-Varley voltage divider, coupled to the TRANSFERMATIC switch, provides a known adjustable reference voltage. The divider is capable of increments smaller than 10 μ volts. For input voltages greater than 10 volts the unknown is divided down by an input attenuator. Input impedance on the 100 volt and 1000 volt ranges is 10 megΩ. Because of no input attenuator on the 1 volt and 10 volt ranges, input impedance is infinite at null. Models 205 and 206, with an accurate 1000 volt reference voltage, have infinite input impedance in all ranges when at null.

A five-position sensitivity switch allows the front panel null meter to display ±100%, ±10%, ±1%, ±.1% or ±.01%* of the voltage range as a full scale reading. This provides a high degree (up to 2 ppm) of scale expansion about any point in all voltage ranges.

*Not applicable to Models 201 and 202.

When used as a differential voltmeter, these models operate on the potentiometric principle. To obtain a reading, the internal reference is divided down to equal the unknown voltage with the aid of a null meter. The unknown voltage is then read directly from the divider dials.

In the ±100% position, the instrument operates as a direct reading voltmeter. The TRANSFERMATIC switch is not connected to the null amplifier. This mode is useful for rapid and approximate voltage (±3%) and polarity measurements. For more accurate measurements, it is then only necessary to select the proper polarity and desired null sensitivity. Next, start turning the dial at the left in the direction that the meter indicator should move. When the indicator swings to the opposite side, the second dial is turned in the direction that the indicator should move. Following the same process through the dials from left to right, a null can be achieved without resetting all digits to zero and without resetting all switches when transfer points are reached.

The speed at which the voltmeter can be nulled by the operator makes the instrument ideal for use on a production line as well as in the laboratory. It is this speed of operation that makes the DIALAMATIC Differential Voltmeter unique. The increase in speed is due to the TRANSFERMATIC switch action coupled with a null amplifier which never loses sense and an amplifier-meter output indicator with sufficient band width and step response. For this reason the operator will never become confused or lose time waiting to see what effect his last adjustment is going to have on the reading.

The DIALAMATIC Differential Voltmeters have extremely high leakage resistance to ground. This minimizes the errors due to a-c and d-c common mode voltages. Other features included are a polarity switch for equal convenience when measuring positive and negative voltages and recorder output which makes the instrument useful for monitoring the stability of a-c or d-c voltages. The recorder output is proportional to the null meter reading.

SECTION II
SPECIFICATIONS

This section contains specifications for the WAVETEK DIALAMATIC Voltmeters and/or Hertzmeters.

GENERAL

DISPLAY

Four Transfermatic digital dials, including one vernier dial calibrated to two digits, resulting in 5-digit resolution; mirror scale taut band null detection meter.

RECORDER OUTPUT

Output is proportional to null reading; ±300 mv full scale. Output impedance 10 KΩ.

ENVIRONMENTAL

Specifications apply for 25°C ±5°C. For operation from 0°C to 50°C, derate by a factor of 3.

WARMUP TIME

DC and Hertz - 5 seconds; AC - 2 minutes; all specifications apply after one hour.

POWER REQUIREMENTS

115 volts ±10% or 230 volts ±10%, 50 Hz to 400 Hz, less than 10 watts. Hertzmeters and D-C/Hertzmeters - less than 20 watts, battery models.

POWER REQUIREMENTS - Battery Models (DC and DC/AC Voltmeters only)

Ni-cad rechargeable battery with built-in charger; 115 volts ±10% or 230 volts ±10%, 50 Hz to 400 Hz, less than 10 watts. Simultaneous charge and operation; 10 hours of operation for every 16 hours of charge.

DIMENSIONS and WEIGHT

7 and 3/4" wide, 5 and 1/4" high, 11" deep

8 pounds; battery models - 10 pounds.

VOLTMETER

INPUT

0 to 1000volts d-c
1 mv to 1000 volts a-c,(Models 202, 204 and 206)

SELECTABLE VOLTAGE RANGES

1 volt, 10 volts, 100 volts, and 1,000 volts (decimal indicator automatically coupled to range switch).

POLARITY

Front-panel selected plus (+) and minus (-)

RESOLUTION

Null Meter: 2 μ volts (1 minor division on mirror scale of null meter). 20 μ volts for Models 201 and 202.
Transfermatic Switch: 0.001% of range (1 part in 100,000)

NULL RANGES

Full scale meter sensitivity is ±0.01%,* 0.1%, 1%, 10%, and 100% of selected voltage range. Operates as a direct reading voltmeter in 100%. *Not applicable to Models 201 and 202.

NOTE

Normally used in most sensitive position because of non-saturating null amplifier.

D-C INPUT IMPEDANCE

Infinite at null in 1 volt and 10 volt ranges, 10 megohms in 100 volt and 1,000 volt ranges.
Infinite at null in all ranges for Models 205 and 206

A-C INPUT IMPEDANCE (Models 202, 204 and 206)

1 megohm and 40 pf.

D-C ACCURACY

±0.01% of reading ±0.001% of selected voltage range ±10 μ volts.

A-C ACCURACY

±0.2% of reading ±25 μ volts, 20 Hz to 10 KHz, 0.001 volt to 1,000 volts.

±1% of reading ±25 μ volts, 10 KHz to 20 KHz, 0.003 volts to 1,000 volts.

REFERENCE STABILITY

±0.002% after 15 minutes warmup at constant temperature and line. Temperature coefficient less than 5 ppm/°C.

COMMON MODE REJECTION

With 1 KΩ unbalance in either side of input, up to 70% relative humidity.

Voltage Ranges	Common Mode Voltage		
	DC	60 Hz	400 Hz
1 volt & 10 volt	130 db	100 db	90 db
100 volt & 1000 volt	100 db	85 db	70 db

NOTE

Ni-cad battery Models 201B, 202B, 203B and 204B provide complete line isolation.

DIRECT READING VOLTMETER (100% Meter Sensitivity)

1, 10, 100 and 1,000 volts full scale.
Accuracy 3% of full scale.

SECTION III
OPERATING INSTRUCTIONS

FUNCTION OF CONTROLS

IDENTIFICATION	FUNCTION
TRANSFERMATIC SWITCH	Used to divide down internal reference frequency to match the unknown input; provides readout of unknown input.
METER SENSITIVITY (% of RANGE)	Selects the null meter full scale sensitivities of ±0.01%*, ±0.1%, ±1%, ±10% or ±100% of range.
METER	Indicates approximate input when METER SENSITIVITY is set to 100% of RANGE and the difference between the unknown and internal reference when used as a null detector.
MECHANICAL ZERO CONTROL	Sets the meter to zero mechanically. This adjustment should be used only after the instrument is turned off.
RECORDER OUTPUT	An output, proportional to the null meter reading, for driving an external recorder.
FUSE	The fuse is a 1/2 amp slow-blow type for 115 VAC operation. If the instrument is converted for 230 VAC operation change the fuse to 1/4 amp slow-blow type.

* Not applicable to Models 201 and 202.

IDENTIFICATION	FUNCTION
+ and — terminals	Input for unknown voltage
Chassis ground terminals	Used for grounding (See common mode and grounding considerations)
FUNCTION	Provides AC line power to transformer in all positions except off; changes polarity of input terminals of all DIAL-AMATIC Voltmeters as standard functions and also provides special functions as follows: Connects AC converter to input for measurement of AC voltage (Models 202, 204 and 206). Connects frequency converter to input for measurement of frequency (Model 207 only). Applys battery supply voltages to voltmeter circuits of "B" models - 201B, 202B, 203B and 204B. *
RANGE	Selects the desired voltage range of 1, 10, 100, or 1000 volts. Positions decimal point for voltage readout dials.
ZERO ADJUST (Models 201, 202, 203, 204, 205, 206 and 207)	Provides compensation for minor drifts in the null amplifier. This should be adjusted only after the instrument has been on for at least one hour. When checking or adjusting for offsets, set controls as follows: + and — inputs shorted, TRANSFERMATIC switch .0000, RANGE at 1, and METER SENSITIVITY to 0.01%.

* AC power is applied to battery charging circuit whenever instrument is connected to AC line.

GENERAL

The DIALAMATIC Differential Voltmeters may be used to measure unknown DC voltages, (DC/AC on Models 202, 204 and 206). These instruments are also useful for monitoring voltage drift about a known voltage, or to adjust a voltage to a precise value. Suggested procedures for these operations are outlined in this section. For critical measurements, turn the instrument on and allow an hour warmup period. The instrument may be used immediately for less critical measurements.

Measurement of an Unknown Voltage

Preset controls as follows:

RANGE	1000 v
METER SENSITIVITY	100 %
FUNCTION	+
TRANSFERMATIC SWITCH	all zeros

1) Connect the unknown voltage to the + and − input terminals. If one side is grounded, connect it to the − terminal.

2) Set the RANGE switch to the lowest range that will permit on-scale meter deflection.

3) If meter deflection is to the right, the polarity of the input voltage is negative. Turn FUNCTION switch to negative.

4) Set readout dials to the approximate value displayed on the meter and note the position of the decimal point.

   NOTE: Because of the speed of operation of the TRANSFERMATIC switch, it is not necessary to perform this step unless desired.

5) Set meter sensitivity to any desired null sensitivity.

   NOTE: Because of the ease of operation of the TRANSFERMATIC switch, METER SENSITIVITY may be set directly to the most sensitive null position desired.

6) Start turning the dial at the left in the direction the meter needle should move towards zero. When the meter needle swings to the opposite side, the second dial is turned in the direction the meter needle should move. Follow this same process through the dials from left to right until a null is obtained.

7) When a null has been obtained at the desired sensitivity, the unknown voltage can be read directly from the readout dials.

Monitoring Voltage Drift About a Center Voltage

1) Set METER SENSITIVITY to 100%. Connect the unknown voltage to the + and − input terminals.

2) Set the proper RANGE. Set TRANSFERMATIC switch readout dials to the desired center voltage. The null meter indication should agree with the significant number indication on the readout dials.

3) Switch METER SENSITIVITY to 10%. Any deflection on the null meter now indicates the difference between the center voltage as set in and the actual voltage based on a full scale deflection of ±10% of the indicated voltage range.

4) If the difference voltage is less than 1% of range, indicated as less than one minor division deflection, the METER SENSITIVITY switch may be set to 1% still keeping the deflection on scale.

5) If the difference voltage is still less than one major division deflection, the sensitivity may again be increased. This process may be continued until the desired sensitivity is obtained.

6) When the final sensitivity is obtained, the null meter gives a dynamic indication of the difference voltage with full scale meter deflection being a percentage of the range as indicated by the METER SENSITIVITY switch.

Recording Voltage Drift

1) Perform the first three steps of Monitoring Voltage Drift About a Center Voltage.

2) Set METER SENSITIVITY to the most sensitive position within limits of expected drift.

3) Connect a recorder to the RECORDER OUTPUT terminals. Unbalance the TRANSFERMATIC switch to obtain full scale needle deflection in one direction then the other. Set recorder balance and gain to match the high and low full scale meter deflection. Reset readout dials to desired center voltage.

4) The recorder will now display voltage excursions with plus and minus full scale being a percentage of the desired voltage range.

NOTE: Recorder output voltage is approximately ±250 mv to ±300 mv for full scale deflection. Output impedance is 10 KΩ. A recorder with high (100K) input resistance should be used to prevent loading the null meter. If the leakage between the recorder input terminals and ground is less than 5,000 megohms the accuracy and common mode rejection of the voltmeter will be affected.

Adjusting an Unknown Voltage

1) Set METER SENSITIVITY to 100%. Connect the unknown voltage to the + and − input terminals.

2) Set proper RANGE. Set TRANSFERMATIC switch readout dials to the desired voltage.

3) Adjust the unknown voltage until the null meter needle deflection indicates the proper voltage based on full scale deflection of 100% of range.

4) Set the METER SENSITIVITY switch clockwise one position at a time and adjust the voltage source for less than one minor division of needle deflection on the null meter. Repeat this step until the desired null sensitivity is obtained.

DIRECT READING VOLTMETER OPERATION

The DIALAMATIC can be used as a direct reading voltmeter (±3% accuracy) with full scale sensitivities from 100* microvolts to 1000 volts. Set METER SENSITIVITY switch to the 100% position to operate the instrument as a direct reading voltmeter. The TRANSFERMATIC switch is not connected to the null amplifier when the METER SENSITIVITY switch is set to 100%. Four full scale ranges of 1, 10, 100, and 1000 volts are selectable with RANGE switch. Proceed with steps 1, 2, and 3 as stated in Measurement of an Unknown Voltage.

Additional direct reading voltmeter ranges from 100* microvolts to 100 millivolts full scale can be made available by using other positions of the METER SENSITIVITY switch. For this mode of operation set the TRANSFERMATIC switch readout dial to all zeros and the RANGE switch to the 1 volt position. Full scale ranges are available as follows:

METER SENSITIVITY	RANGE
0.01%‡	0-100 μv
0.1%	0-1000 μv
1%	0-10 mv
10%	0-100 mv

AC MEASUREMENTS (Models 202, 204 and 206)

The DC/AC Models have an a-c to d-c average responding converter calibrated to RMS voltage. For a-c measurements set the FUNCTION switch to AC. Proceed with the steps as outlined in Measurement of an Unknown Voltage omitting step 3.

* 1 mv for Models 201, 202
‡ Not applicable to 201, 202

COMMON MODE AND GROUNDING CONSIDERATIONS

A potential difference generally exists between different points on power systems ground. If the – input terminal of the voltmeter is connected to the chassis ground post at the voltmeter, the voltmeter will read the sum of the input signal and the potential difference along the power systems ground. This potential difference is known as a common mode voltage since it is common to both the + and – input lines. See Figure 3-1. The common mode voltage may be a-c as well as d-c. Under these conditions, the input should not be grounded at the voltmeter. Under certain conditions it may be desirable to ground the meter provided no common mode voltage exists. In order to maintain the high common mode rejection, the leakage resistance from the circuitry to chassis ground has to be extremely high to reduce the ground loop currents.

The leakage resistance from the power supplies to power ground form a high impedance bridge which is very hard to match (see Figure 3-2). Accuracy can suffer if the positive input of the amplifier is grounded and the source resistance is high. For source resistances of 100K or less, generally there is no loss in accuracy if the positive input of the amplifier is grounded. If it is necessary that this input be grounded, the meter should be zeroed.

Great care should be exercised when servicing the instrument so it does not become contaminated resulting in a lower leakage resistance. Leakage resistances to the chassis in the order of $10^{11}\Omega$ from the null amplifier common, and much higher values from the input attenuator, are necessary to insure the common mode performance. Since leakage resistance is dependent upon dampness, the common mode measurements should be made with a relative humidity below 70%. For high common mode voltages, the measurement should be made several minutes after application of the voltage since it takes time to charge stray capacities to ground through very high leakage resistances.

A 0.01 μf capacitor is connected from the – input terminal to chassis ground to reduce the effect of a-c leakage currents from the power transformer. It is possible under some conditions, such as when making common mode tests, for this capacitor to acquire a charge. Since in subsequent tests an error may exist until this capacitor discharges, the – input terminal should be shorted to chassis to provide a low impedance path for discharge.

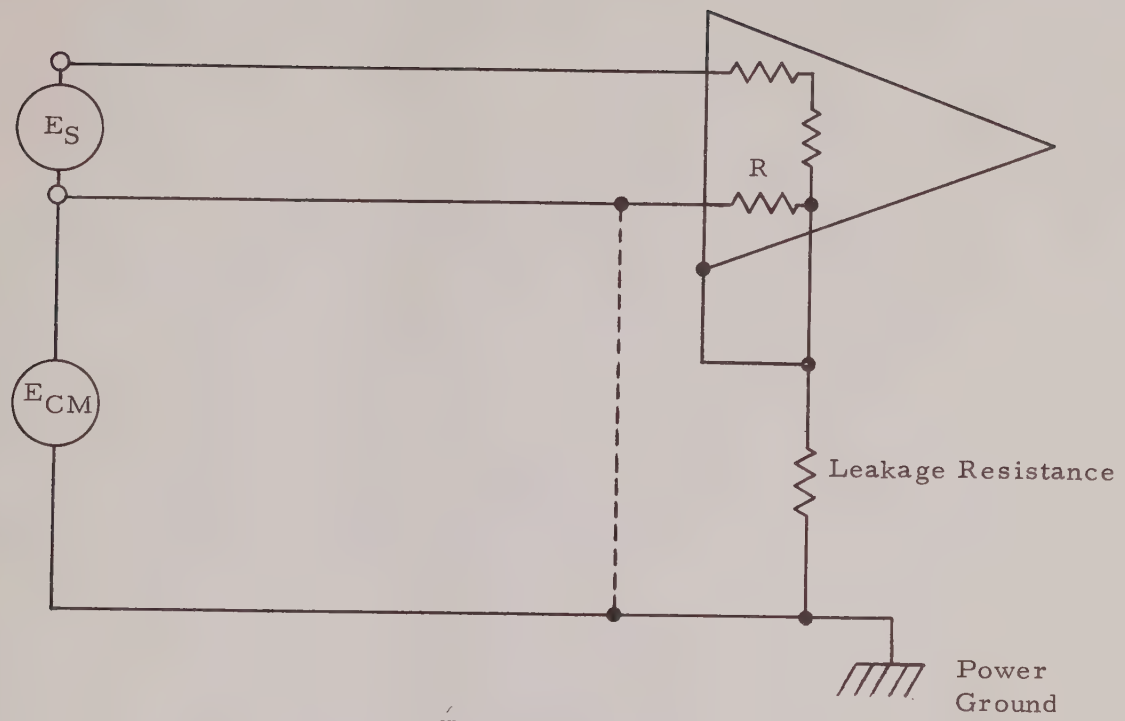


Figure 3-1.

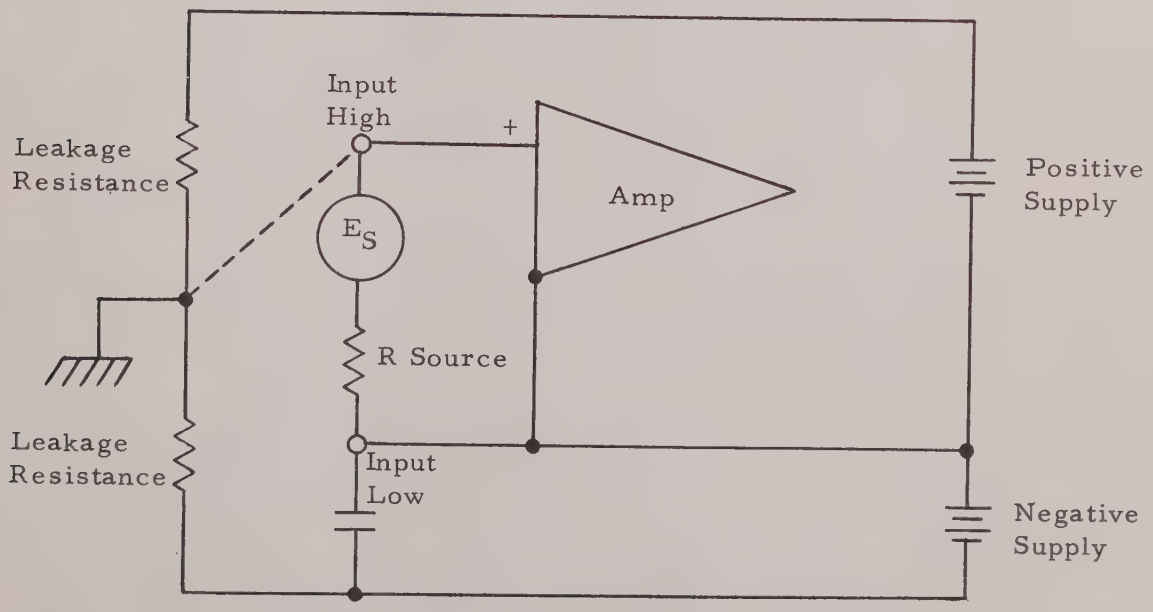


Figure 3-2.

SECTION IV
THEORY OF OPERATION

GENERAL

A simple block diagram of the differential voltmeter mode is shown in Figure 4-1. The differential mode consists of a series circuit of the unknown input voltage (E_S), an accurately adjustable bucking voltage (E_B), and a null amplifier driving a meter to read the difference between E_S and E_B. The polarity of E_S is reversible so that when the magnitude of E_B is adjusted equal to E_S, they will subtract and the amplifier will indicate a null. Under these conditions of balance or null, the current flowing across the input circuit will be zero and the input impedance will approach infinity. It is evident that if other leakage paths exist, the input impedance will be limited. Extreme care has been exercised at the factory to keep the voltmeter clean and extra isolation has been provided to insure the high input impedance.

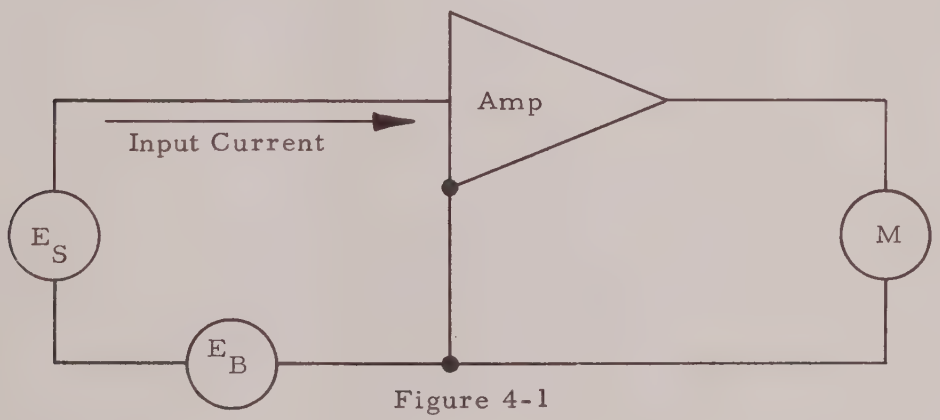
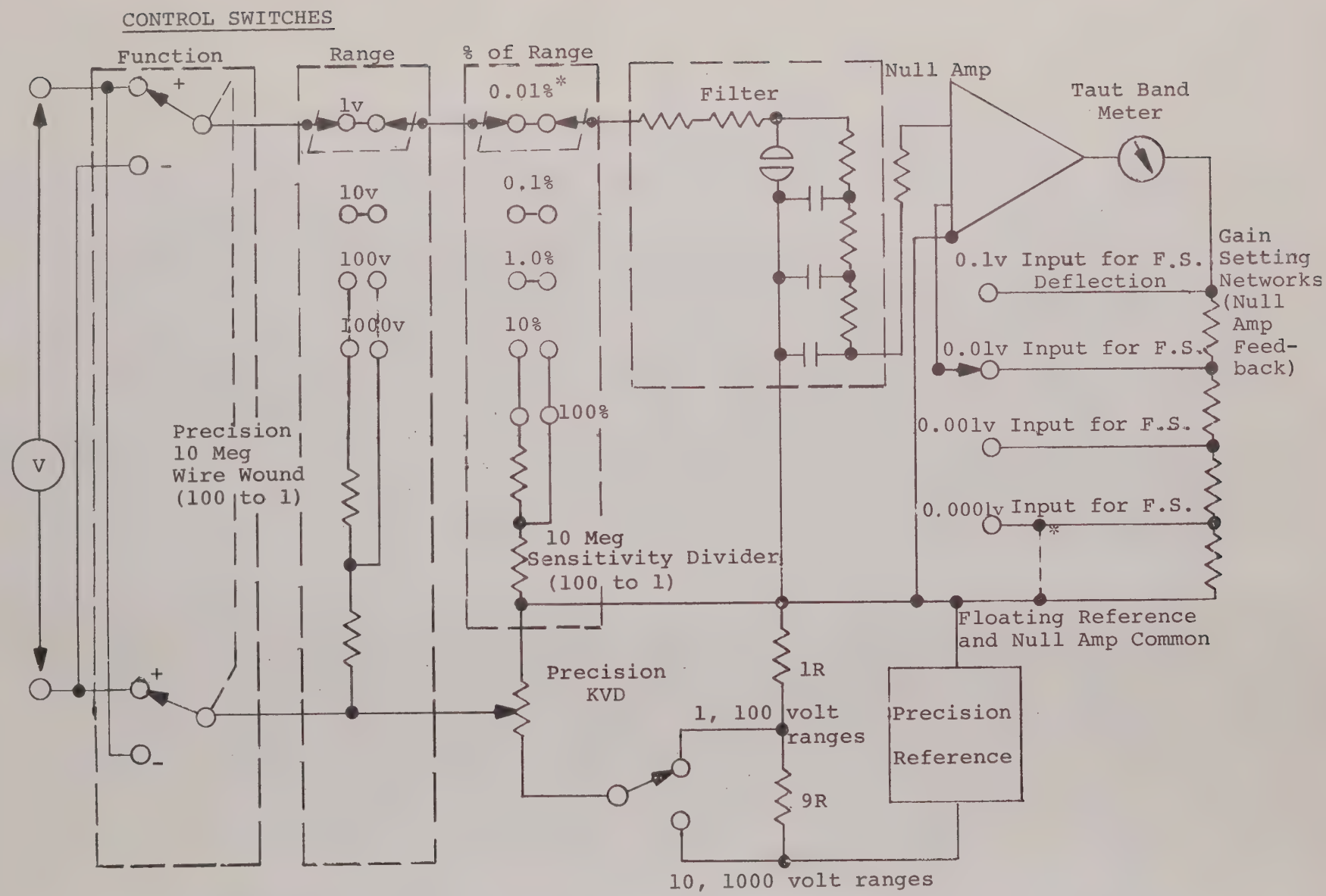


Figure 4-1

Figure 4-2 is a detailed block diagram of the differential mode which illustrates the signal flow and the basic block expansion for additional capabilities.

INPUT ATTENUATOR (Models 201, 202, 203, 204 and 207)

An input attenuator, R119 and R120 on the range board schematic, is used to scale down input voltages which are greater than 10 volts. This is necessary since the highest reference voltage used is 10 volts. A reference voltage of one volt is used for the 1 and 100 volt ranges. The scaled down input voltage is then balanced out by the bucking voltage as before. The accuracy is now dependent upon the accuracy of the input attenuator. The attenuator consists of three 3.3 Megohm and one 100Kohm wirewound resistors for stability and one 10 Kohm potentiometer, R104, for adjustment to an exact 100 to 1 attenuation. The input impedance is limited to 10 Megohm for input voltages greater than 10 volts.



*0.01% of Range and 0.0001 Input for F.S. Not Used on Models 201 and 202.

Figure 4-2.

The null amplifier of the basic block diagram, Figure 4-1, has been expanded in Figure 4-2 to include a 100 to 1 sensitivity divider, an input filter, the potentiometric null amplifier, and the feedback gain setting networks.

SENSITIVITY DIVIDER

The 100 to 1 sensitivity divider is composed of metal film resistors. At a perfect null, the divider will have zero volts across its and so will not affect the accuracy of the indicated reading. For a null meter indication other than zero, the deflection accuracy is dependent upon the accuracy of this divider. However, metal film resistor accuracies are consistent with the accuracy of the best meter movements available.

INPUT FILTER AND LIMITER

The input filter is a three-pole RC low pass filter designed to give 60 db attenuation at 50 Hz. The filtering is desirable since large AC input voltages could saturate the null amplifier. Two 150 KΩ, 2 watt resistors and the neon tube form an input voltage limiter. This enables continuous application of 1000 volts d-c to the meter, even when the meter is set on the 1 volt range.

NULL AMPLIFIER

The null amplifier is composed of a dual transistorized chopper followed by a d-c coupled differential carrier amplifier with common mode feedback, a full wave demodulator for a d-c to a-c to d-c gain of approximately 200. This is followed by a post amplifier. The combination of the d-c coupled carrier and the output limiting of the post amplifier give the null amplifier its very rapid overload recovery.

FEEDBACK NETWORK

The feedback network provides for a null amplifier gain of 0.1, 0.01, 0.001 and 0.0001* volts for full scale meter deflection. The amplifier output current goes through the meter and to the attenuator resistors. This feedback establishes a precise current through the meter and makes the deflection independent of the meter resistance wich is desirable since the meter responds to current rather than voltage.

Table 4-1 summarizes the switching logic and signal conditioning.

As indicated by the block diagram (Figure 4-2), the three most important factors with regard to accuracy are 1) the precision of the input attenuator, 2) the accuracy of the Kelvin-Varley Divider (KVD), and 3) the accuracy of the reference voltage. Wirewound resistors (±5 ppm/^{o}c) are used in all three. The reference utilizes two temperature matched zener diodes. A positive TC is matched with a similar negative TC to assure a near zero TC for the pair.

*Not Applicable to Models 201 and 202.

CONTROL SWITCHES			Sensitivity Divider	Input Atten.	Voltage Across KVD	Null Amp Gain (input voltage for full scale deflection)
Function	Range Volts	% of Range				
DC + or -	1	0.01*	-----	-----	1	0.0001
	1	0.1	-----	-----	1	0.001
	1	1	-----	-----	1	0.010
	1	10	X.01	-----	1	0.001
	10	0.01*	-----	-----	10	0.001
	10	0.1	-----	-----	10	0.010
	10	1	-----	-----	10	0.100
	10	10	X.01	-----	10	0.010
	100	0.01*	-----	X.01	1	0.0001
	100	0.1	-----	X.01	1	0.001
	100	1	-----	X.01	1	0.010
	100	10	X.01	X.01	1	0.001
	1000	0.01*	-----	X.01	10	0.001
	1000	0.1	-----	X.01	10	0.010
	1000	1	-----	X.01	10	0.100
	1000	10	X.01	X.01	10	0.010
100% (Direct Reading Volt-meter)	1	----	X.01	-----	--	0.010
	10	----	X.01	-----	--	0.100
	100	----	X.01	X.01	--	0.010
	1000	----	X.01	X.01	--	0.100

*Not Applicable to Models 201 and 202

Table 4-1.

A-C CONVERTER

Figure 4-B-1 is a detailed block diagram of the a-c converter which, in a-c mode, is switched in series in front of the d-c voltmeter and programmed to the 1 volt range. The d-c voltmeter is connected across the rectified and filtered differential output of the a-c converter, thus providing full wave rectification. The two rectified outputs are summed together at point A to provide a feedback signal. The a-c converter is an operational amplifier with sufficient loop gain (greater than 80 db) to insure stability and linearity from an input level of 1 millivolt to 1 volt, which is the full scale output level (from 20 Hz to 20 KHz). The converter responds to the average of the input waveform and is calibrated to RMS voltage. The ranging is accomplished by using a 200 KΩ metal film feedback resistor to set the gain on the 1 volt range. This value is decaded lower for the next higher range and down to an equivalent 200Ω for the 1000 volt range. The input resistor is composed of two 500 KΩ 2-watt metal film resistors, R238 and R239, to provide a safe voltage of up to 1500 volts for the resistors and, also, to provide a lower voltage coefficient. Each feedback resistor is in series with a small potentiometer to adjust the gain. The 1000 volt feedback resistor is the only range not having a variable capacitor, so the capacitors across the input resistor are used to adjust the 1000 volt range high frequency gain. Since this is common with the other ranges, the 1000 volt high frequency adjustment must be made on the 1000 volt range first. The high frequency gain adjustment is always made last. Any d-c component in the a-c input signal is blocked by the 1000 volt 0.5 microfarad input capacitor. This capacitor, together with the capacitor at the summing junction (point J) and the capacitor at the diode rectifiers (point B), insures that d-c bias potentials from the input or the amplifier do not add to the rectified a-c output. The high gain amplifier is composed of four differential stages summed with a fifth single stage output transistor. D-c feedback is used from the fourth differential output to stabilize the d-c quiescent potentials. The input differential stage is a pair of N channel field effect transistors, Q205 and Q206, to provide low noise with high source impedance and to provide a high impedance load on the summing junction.

CONTROL SWITCHES			Voltage Across KVD	Null Amp Gain (input voltage for full scale deflection)
Function	Range Volts	% of Range		
AC*	1	0.1	1	0.001

*Models 202, 204 and 206

TABLE 4-B-1

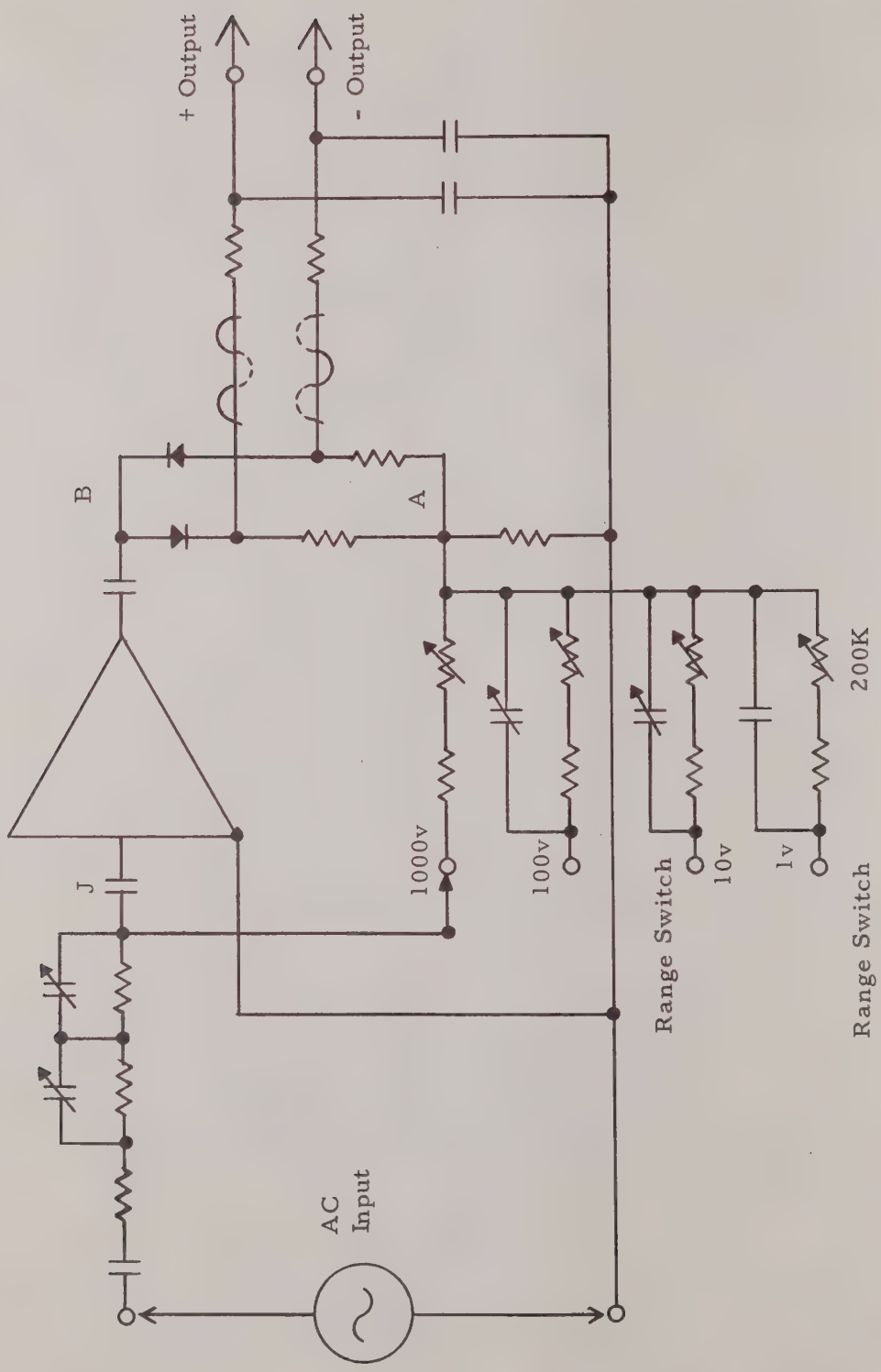

+ Output
- Output
B
A
J
1000v
100v
10v
1v
Range Switch
Range Switch
200K
AC
Input

Figure 4-B-1

PRECISION REFERENCE SUPPLY

Figure 4-3 shows the basic block diagram of the reference supply; refer also to the null amplifier board schematic. The amplifier consists of a low drift differential pair, Q17 and Q18, followed by an output stage, Q15 and Q16, and a series regulator, Q14. CR1 and CR2, in series, provide the reference voltage.

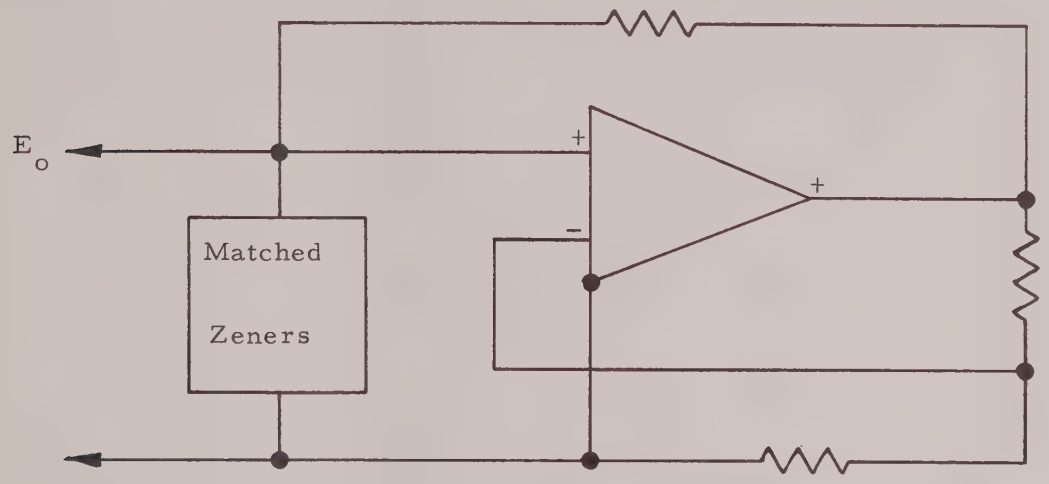


Figure 4-3

This combination provides a stable and precise current for the zener diodes and, therefore, forms an accurate reference when the load across the zener is constant.

NULL AMPLIFIER.

Refer to the null amplifier board schematic. The null amplifier is composed of a mos-fet chopper followed by a d-c coupled carrier amplifier with common mode feedback, Q21 through Q26, and a full wave demodulator for a d-c to a-c to d-c gain of approximately 200. This is followed by an integrated circuit post amplifier with a gain of approximately 1000. The input signal is fed directly to the carrier amplifier, while the feedback from the post amplifier goes to the N-channel mos-fet switch, Q19.

Chopper drive for the mos-fets and demodulator is obtained from IC1 through buffer amplifiers Q5 and Q6 at a frequency of 165 Hz. When the two mos-fets are turned on together, the feedback signal from the post amplifier IC2 is coupled to the carrier amplifier. The feedback signal level overrides the input signal because of the low impedance drive of the post amplifier output coupled through Q19. When Q19 and Q20 are turned off, the carrier amplifier sees the input signal. No signal actually passes through the P-channel mos-fet, Q20. Its function is to neutralize the switching spikes and provide thermal balance for Q19.

Q9 and Q10 compose full wave demodulator circuit. These transistors are on alternately, driven by Q6, and sum the carrier amplifier output through R21 and R23. The signal is then applied to the post amplifier, IC2.

An output limiting circuit composed of Q12 and Q13 limits the output voltage swing to approximately ±600 mv. The combination of the d-c coupled carrier amplifier and the output limiting of the post amplifier give the null amplifier very rapid overload recovery.

Regulated +6 volts is provided by a regulator, Q1 and Q2. Reference voltage for this supply is obtained from the -17 volt regulator described under Precision Reference Supply. Q3 and Q4 are the -6 volt regulator with reference to the +6 volt supply through R5. Current for the -6 volt supply is obtained from the -17 volt regulator.

FEEDBACK NETWORK

The feedback network provides for a null amplifier gain of 0.1, 0.01 and 0.001 and 0.0001* volts for full scale meter deflection. The amplifier output current goes through the meter and to the attenuator resistors. This feedback establishes a precise current through the meter and makes the deflection independent of the meter resistance which is desirable since the meter responds to current rather than voltage. R123 is switched out to compensate for the loading of the attenuator on the 100 and 1000 volt ranges for the 0.01%*, 0.1% and 1% null sensitivities.

DIRECT READING VOLTMETER MODE

Figure 4-4a is a detail block diagram of the direct reading voltmeter mode. The meter reads an attenuated input voltage and the deflection is proportional to the input voltage. Four full scale ranges of 1, 10, 100, and 1000 volts are available. The input impedance is 10 megs for all ranges (See Table 4-1).

RECORDER OUTPUT

Full scale output of the voltmeter at the recorder output terminals on the rear panel is a nominal 300 millivolts. The output is isolated by two 4.7K resistors, R67 and R68, located on the d-c board. The recorder input should be well isolated so there will be no degradation in common mode rejection and no offsets due to circulating ground currents.

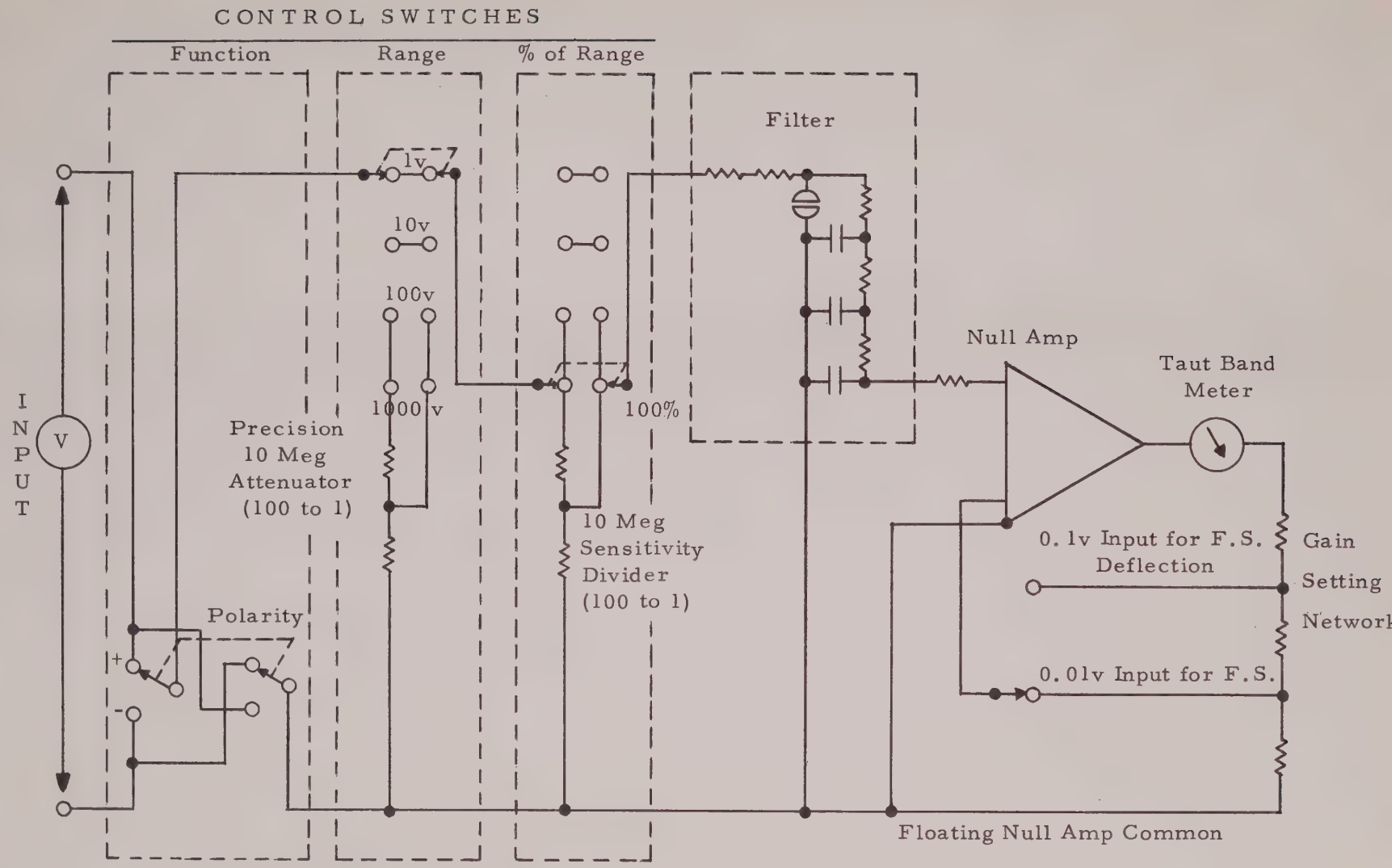

CONTROL SWITCHES
Function
Range
% of Range
Filter
1v
10v
100v
1000v
100%
INPUT
V
Precision
10 Meg
Attenuator
(100 to 1)
10 Meg
Sensitivity
Divider
(100 to 1)
Polarity
+
-
Null Amp
Taut Band
Meter
0.1v Input for F.S.
Deflection
Gain
Setting
Network
0.01v Input for F.S.
Floating Null Amp Common

Figure 4-4a

SECTION V
MAINTENANCE

GENERAL

In the event of improper operation of the voltmeter, the trouble area can usually be isolated to one of several specific circuits. This can be done by the use of the equipment schematic diagrams and suitable test equipment. To facilitate troubleshooting, the following information is provided. However, before proceeding with detailed troubleshooting, be sure that the trouble cannot be corrected by a calibration adjustment.

PERFORMANCE CHECK

Connect a wide range, precision power supply, such as a Kintel Model 326, or equivalent, to the input terminals. Set the voltmeter as shown in Table 5-1 to check operation as a direct reading voltmeter. Set the voltmeter as shown in Table 5-2 to check operation as a differential voltmeter.

KVD SETTING	RANGE	METER SENSITIVITY	INPUT VOLTAGE	METER READING
.0000	1v	100%	±1v	±Full Scale
.0000	1v	10%	±0.1v	±Full Scale
.0000	1v	1%	±10mv	±Full Scale
.0000	1v	0.1%	±1mv	±Full Scale
.0000	1v	0.01%*	±100μv	±Full Scale
0.000	10v	100%	±10v	±Full Scale
0.000	10v	10%	±1v	±Full Scale
0.000	10v	1%	±0.1v	±Full Scale
0.000	10v	0.1%	±10mv	±Full Scale
0.000	10v	0.01%*	±1mv	±Full Scale
00.00	100v	100%	±100v	±Full Scale
00.00	100v	10%	±10v	±Full Scale
00.00	100v	1%	±1v	±Full Scale
00.00	100v	0.1%	±0.1v	±Full Scale
00.00	100v	0.01%*	±10mv	±Full Scale
000.0	1000v	100%	±1000v	±Full Scale
000.0	1000v	10%	±100v	±Full Scale
000.0	1000v	1%	±10v	±Full Scale
000.0	1000v	0.1%	±1v	±Full Scale
000.0	1000v	0.01%*	±0.1v	±Full Scale

*Not Applicable to Models 201 and 202

Table 5-1

KVD SETTING	RANGE	METER SENSITIVITY	INPUT VOLTAGE	METER READING
.5000	1v	10%	±0.500v	Null
.5000	1v	1%	±0.500v	Null
.5000	1v	0.1%	±0.500v	Null
.5000	1v	0.01%*	±0.500v	Null
5.000	10v	10%	±5.000v	Null
5.000	10v	1%	±5.000v	Null
5.000	10v	0.1%	±5.000v	Null
5.000	10v	0.01%*	±5.000v	Null
50.00	100v	10%	±50.00v	Null
50.00	100v	1%	±50.00v	Null
50.00	100v	0.1%	±50.00v	Null
50.00	100v	0.01%*	±50.00v	Null
500.0	1000v	10%	±500.0v	Null
500.0	1000v	1%	±500.0v	Null
500.0	1000v	0.1%	±500.0v	Null
500.0	1000v	0.01%*	±500.0v	Null

*Not Applicable to Model 201 and 202

TABLE 5-2

Input Divider

The input divider, R104, R119, and R120 shown in the range board, is inserted at all times when the voltmeter is in the 100 or 1000 volt ranges. These resistors will affect both meter deflection accuracy and KVD readout accuracy on these ranges only. Check the input divider circuit resistors by means of a precision resistance bridge. If this is not available, the 3.3 megohm resistors may be checked by applying a voltage across the HIGH and LOW input terminals with the RANGE switch set to 100 or 1000 volts. Measure the voltage drop across each resistor with a suitable voltmeter.

NOTE: Since these resistors are relatively high in value, consider meter loading. Accuracy check will be limited to the accuracy of the voltmeter used.

Null Sensitivity Divider

The null sensitivity divider, R101, R102, and R106, shown on the range board schematic, is inserted at all times when the meter SENSITIVITY switch is in the 10% or 100% positions on all voltage ranges. An error in this divider circuit will cause an improper reading off null at these sensitivities. It will not affect voltage readout accuracy at null.

POWER SUPPLIES

Generally, the first step in troubleshooting is to check the power supply voltages. Be sure the instrument is plugged in, turned on, and the line fuse is intact. Four separate DC voltages, measured with respect to null amplifier common (terminal No. 1 or No. 4), should be present on the null amplifier board. An additional DC voltage, measured with respect to AC Converter common (terminal No. 2), should be present on AC Converter board.*

NULL AMPLIFIER

VOLTAGE	LOCATION	REMARKS
-17v ±170 mv	Case of Q14	less than 1 mv noise and ripple
-10v	Terminal 12	see Calibration procedure, 10 volt Range for adjustment method.
+6.2 ±0.2v	Terminal 9	less than 5 mv noise and ripple, 1 mv chopper signal
-6.3 ±0.2v	Terminal 8	less than 5 mv noise and ripple, 3 mv chopper signal
AC CONVERTER*		
+12v ±0.6v	junction of R215 and R254	less than 2mv ripple

TABLE 5-3

Reference Supply

Since the null amplifier power supplies are derived from the reference regulator (-17 volt supply), any trouble in the reference supply will likely result in improper operation of the null amplifier. A trouble in the 10 volt reference (-17 volt supply) will show up as an error in voltage readings on the readout dials. Meter deviation with respect to the METER SENSITIVITY setting, with the readout dials at 0000, will not be affected. The resistive divider, R114, R121, and R122 is switched in only when the RANGE switch is in the 1 or 100 volt range. In these two ranges 1 volt should appear across the KVD, and 10 volts should appear across the KVD in the 10 and 1000 volt ranges. If readout error occurs on only the 1 and 100 volt ranges check R114, R121, and R122.

*Models 202, 204 and 206 Only

NULL AMPLIFIER

To check null amplifier, meter, and feed back circuit, apply a test voltage between the plus and minus input terminals of the front panel. See Table 5-1, Page 5-A-1. Choose a voltage range and apply the proper test voltage indicated for the particular METER SENSITIVITY listed on the null amplifier gain column. Check the null meter for full scale deflection. Proper functioning at all sensitivities indicates a properly operating null amplifier and feedback circuit.

Open Loop Gain

With the feedback terminal No. 5 on the null amplifier board shorted to common, an input voltage on terminal No. 7 of plus or minus 25 μv, or less, should cause plus or minus full scale null meter deflection. Loss of gain will show up first at high sensitivities, i.e. 0.01%.

Carrier Amplifier Balance R57

Inability to balance the carrier amplifier is usually caused by a change in characteristics of Q21 and Q26. An unbalance here will cause lack of gain or total inoperation.

Chopper Drive

Chopper drive levels are indicated on the null amplifier board schematic. Phase is referred to the positive going portion of the waveform at the demodulator drive point, base of Q9 and Q10. The drive on gate of Q20 will be a square wave from zero level to a negative level between -4 and -8.5 volts depending on the setting of the neutralization control, R16.

Neutralization - R16

Check the waveform with an oscilloscope at the emitter of Q10. If the chopper spikes cannot be neutralized, the cause is likely a mos-fet, Q19 or Q20 with high leakage. A positive going spike indicates leakage in Q19, a negative spike indicates leakage in Q20.

Post Amplifier - IC2

Check pin 4 of IC2 for -3 volts. IC2 may be defective if the short circuit zero adjust, R24, does not affect the output voltage swing at pin 7 of IC2, with pin 2 shorted to null amplifier common. The gain of IC2 may be checked by removing R21 and R23 and applying a voltage of plus or minus 300 μv to pin 2 of IC2 through a 10K resistor. Plus and minus full scale null meter indication should result.

SECTION VI
CALIBRATION

D-C CALIBRATION

EQUIPMENT REQUIRED

1. Voltmeter, 0.01% accuracy (WAVETEK Model 201 or equivalent).
2. Oscilloscope, Tektronix 422 or equivalent.
3. DC Standard, Kintel Model 326 or equivalent.

To perform calibration of the Null Amplifier Board, remove the two left side rails and swing the board out for easy access to calibration controls. If trouble occurs with any step of the procedure, refer to the MAINTENANCE Section for further information.

NULL AMPLIFIER

There are thirteen wires connected to the Null Amplifier Board. Most of these connection points are labeled on the etched side of the board.

Set front panel controls as follows:

FUNCTION	+
RANGE	1 v
METER SENSITIVITY	0.01%
DIALAMATIC SWITCHES	0000

Power Supplies

Connect a voltmeter between common, terminal No. 1 or No. 4, and the respective supply listed below. Check or adjust for the proper voltage. Connect an oscilloscope between common and the voltage listed. Check for specified ripple.

Test Point	Voltage Supply	Tolerance	Adjustment	Ripple (p-p)
Q14 case	-17 v	±170 mv	R35	1mv @ line freq.
Terminal No. 9	+6 v	+6.2v ±3%	------	5mv @ line freq. 3mv choper spikes
Terminal No. 8	-6 v	-6.3v ±3%	------	5mv @ line freq. 3mv chopper spikes

Reference Current

Connect a voltmeter across R71 (453Ω). Adjust Reference Current, R40, for 3.85 volts ±50 mv.

DC Balance

Connect a voltmeter from common to the collectors of Q23 and Q24 respectively. Adjust DC Balance, R57, for equal collector voltage within ±100 mv. (Approximate voltage -3v)

Null Amplifier Neutralization

Connect an oscilloscope between null amplifier common and the emitter of Q10. Adjust Neutralization, R16, for less than 50 mv spikes. Recheck DC Balance.

Short Circuit Zero

NOTE: Before adjusting the short circuit zero control, the mechanical zero of the meter must be checked, and the front panel Zero adjust set to mid-range. See Section III, Function of Controls for procedures. Be sure the DIALAMATIC switch is set to all zeros.

Connect the input cable to the input terminals and short the cable clips together. If there is meter deflection, adjust Short Circuit Zero, R24 for zero on the meter.

Open Circuit Zero

Remove the input cable. If there is a meter deflection, adjust Open Circuit Zero, R53, for zero on the meter.

RANGE CALIBRATION

Set the front panel controls as follows:

FUNCTION	+
RANGE	10 v
METER SENSITIVITY	0.01%
DIALAMATIC SWITCHES	9.500

10 Volt Range

Connect the input cable to the DC Standard and adjust the standard for 9.500 volts. Adjust the 10 volt Range Adjustment, R43, located on the null amplifier board, for a null.

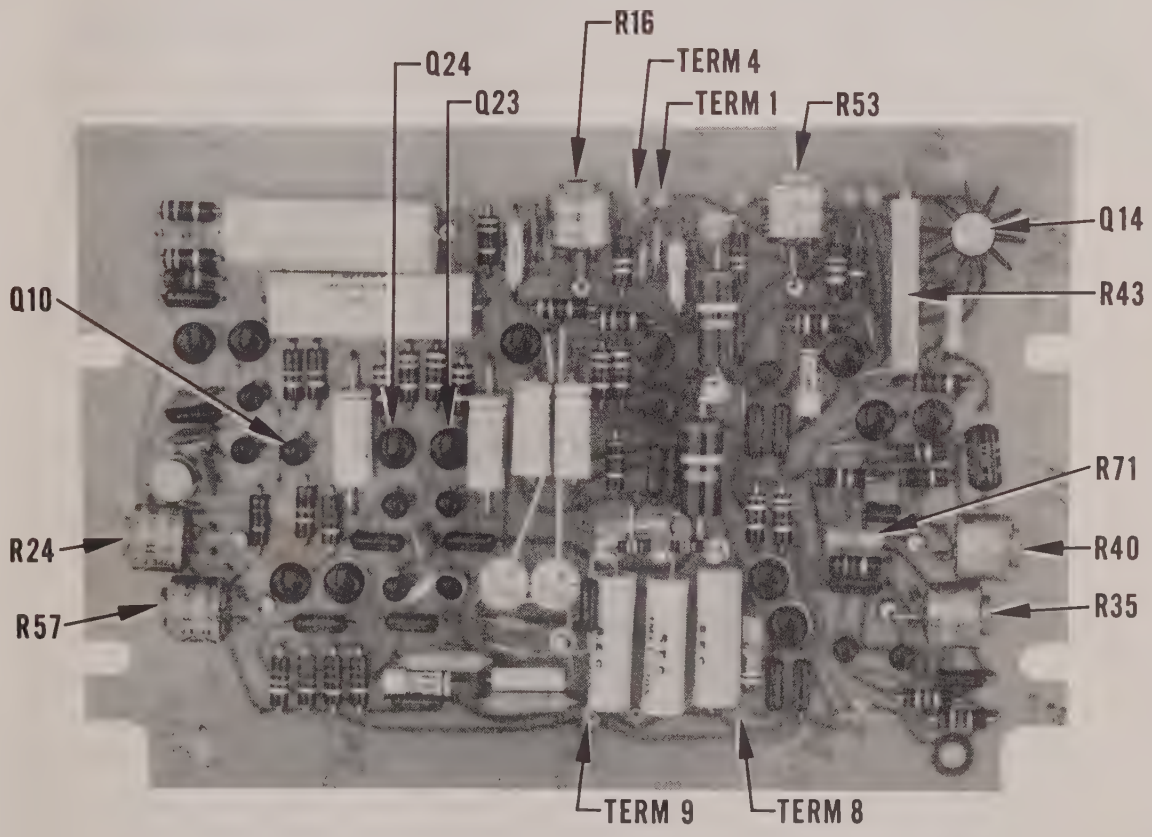


Figure 6-1
Null Amplifier Board
Maintenance/Calibration Locations

1 Volt Range

Change the DC Standard output to 0.95000 volts. Set the RANGE switch to the 1 volt range. Adjust 1 Volt Range Adjustment, R114, located on the Range board, for a null.

100 Volt Range

Change the DC Standard output to 95.000 volts. Set the RANGE switch to the 100 volt range. Adjust 100 Volt Range Adjustment, R104, located on the Range board, for a null.

1000 Volt Range

Change the DC Standard output to 950.000 volts. Set the RANGE switch to the 1000 volt range. Check for a null. (Due to the accuracy of the range resistors, there need not be an adjustment for the 1000 volt range.)

Full Scale Adjust

Set the front panel controls as follows:

FUNCTION	+
RANGE	1 v
METER SENSITIVITY	0.1%
DIALAMATIC SWITCHES	0000
INPUT CABLE	Shorted

Turn the least significant decade (pot) on the DIALAMATIC switch to "10." The meter should read full scale. Adjust Full Scale Deflection Adjustment, R111, for full scale deflection.

DIRECT READING VOLTMETER

Set the front panel controls as follows:

FUNCTION	+
RANGE	As required
METER SENSITIVITY	100%
DIALAMATIC SWITCHES	Any setting, DIALAMATIC is not connected to the meter when the Meter Sensitivity switch is in the 100% position.

Check the 1v, 10v, 100v, and 1000v ranges with the DC Standard (set to .9v, 9v, 90v and 900v respectively. The meter should read 0.9 ±1.5 minor divisions (3% of full scale) on each range.

KVD Linearity Check

Once the DC section has been calibrated, the linearity of the Kelvin-Varley Divider may be checked. For proper linearity the meter should indicate zero within ±0.01% of dial reading, ±0.001% of range, ±10μv for each DC Standard voltage input.

Set the front panel controls as follows:

FUNCTION	+
RANGE	10 v
METER SENSITIVITY	0.1%
DIALAMATIC SWITCHES	0.000

Connect the DC Standard to the high and low input terminals. Rotate each DIALAMATIC decade switch to positions 1 through 9. At each switch position adjust the DC Standard voltage to produce zero meter deflection.

Examples of allowable errors are shown below.

READOUT DIAL	0.010	0.300	8.00
±0.01% of reading ±0.001% of range ±10μv	±1μv ±100μv ±10μv	±30μv ±100μv ±10μv	±800μv ±100μv ±10μv
Error Allowed	±111μv	±140μv	±910μv

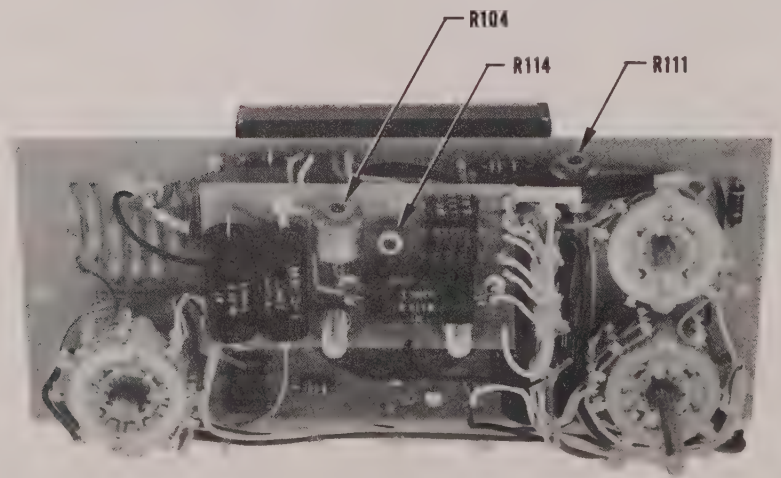


Figure 6-2

A-C CALIBRATION

EQUIPMENT REQUIRED

1. Voltmeter, 0.01% accuracy (WAVETEK Model 201 or equivalent).
2. D. C. Standard, Kintel Model 326 or equivalent.
3. Thermal Transfer Standard, Holt Model 6A or equivalent.
4. A-C Amplifier
5. Oscillator

This combination must be capable of delivering from 0.95 volts — 950 volts at 100 Hz — 10 KHz. Optimation Model 104A or equivalent.

To calibrate the AC Converter, remove the two left side rails and swing the board out for easy access to the calibration controls.

Set front panel controls as follows:

FUNCTION	AC
RANGE	1000 v
METER SENSITIVITY	0.1%
DIALAMATIC SWITCHES	All zeros

BIAS ADJUSTMENT

This adjustment is used to set the static conditions of the output stage for optimum dynamic range. The test point is the unterminated end of a 1 KΩ resistor, R255, connected to the collector of Q211. Connect a voltmeter from AC common, terminal No. 2 or No. 6, to the test point. Adjust R231 for approximately 5.5 v.

RANGE CALIBRATION

The 1000 volt range should be calibrated first because its high frequency adjustment is common to all ranges. To adjust the 1000 volt range, apply a signal of approximately 950 volts at 100 Hz to the input of the Model 204. Use the thermal transfer standard and the DC Standard to measure the true RMS value of the calibration signal. Set the DIALAMATIC switch to this value. Adjust the low frequency calibration control, R241, to obtain a DIALAMATIC meter null. Change the frequency of the input signal to 10 KHz. Measure the true RMS value of the applied signal. Set DIALAMATIC switch to measured value. Adjust the high frequency control (C214 and C215) to obtain a DIALAMATIC meter null.

Follow the same procedure to calibrate the 100v, 10v, and 1v ranges with the exception of Input Signal Amplitude and the Calibration Controls. These three ranges can be adjusted in any order. All adjustment controls are identified on the converter shield. See Table 6-2.

RANGE	FREQUENCY	APPROXIMATE VOLTAGE	ADJUSTMENT
1000 v 1000 v	100 Hz 10,000 Hz	950 v 950 v	R241 C214 and C215
100 v 100 v	100 Hz 10,000 Hz	95 v 95 v	R243 C218
10 v 10 v	100 Hz 10,000 Hz	9.5 v 9.5 v	R245 C220
1 v 1 v	100 Hz 10,000 Hz	0.95 v 0.95 v	R247 C223

Table 6-2

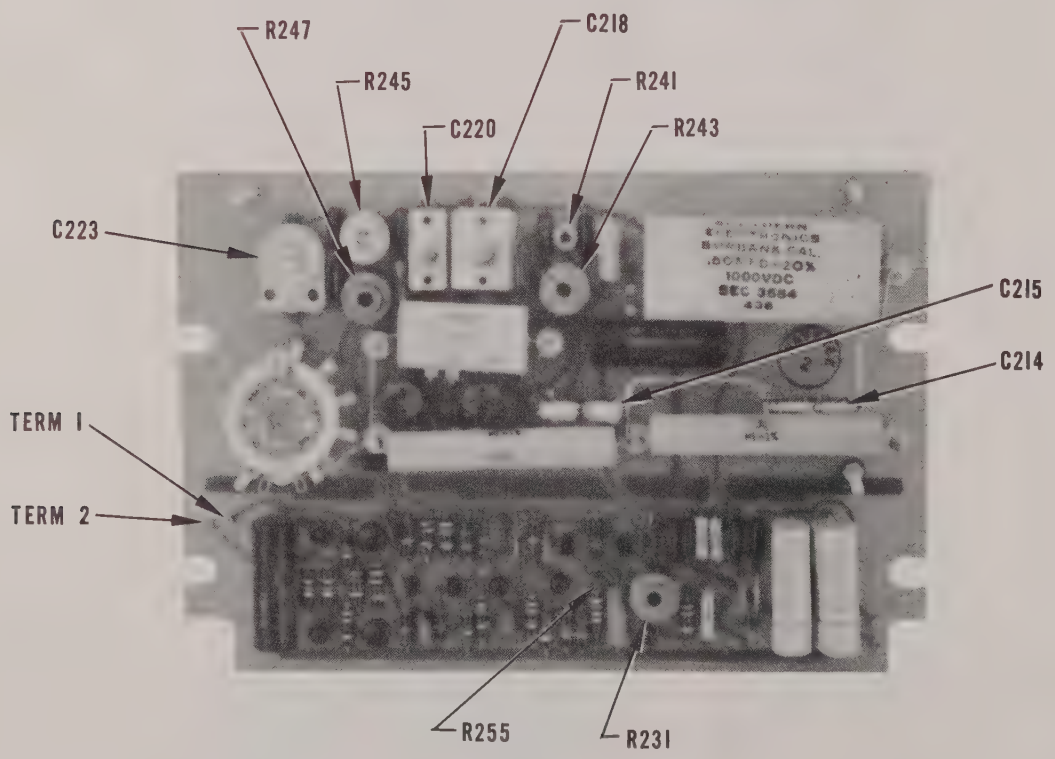


Figure 6-3

SECTION VII
PARTS LIST

GENERAL

This section contains the list of replaceable electronic parts and assemblies in the equipment; structural items and hardware such as screws and nuts are not included.

PARTS LIST ARRANGEMENT

The parts list starts with the Chassis and Front Panel assembly, Figure 7-1, followed by a list of components found on the Chassis as well as the major modular components.

LIST OF MANUFACTURERS

The MANUFACTURER (MFR) column of the parts list uses brief descriptions; the names are given in full below.

Allen Bradley	Allen Bradley, Milwaukee, Wisconsin
ARCO	Arco Electronics, Great Neck, L. I., New York
Beckman	Beckman Systems Division, Fullerton, California
CDE	Cornell-Dubilier Electronics Division, Newark, New Jersey
Corning	Corning Glass Works, Corning, New York
CRL	Centralab, Division of Globe Union, Milwaukee, Wisconsin
CTS	Chicago Telephone, Pasadena, California
Dickson	Dickson Electronics Corporation, Scottsdale, Arizona
Eldema	Eldema Corporation, Compton, California
Elpac	Elpac Incorporated, Fullerton, California
Erie	Erie Technological Products, Incorporated, Erie, Pennsylvania
Fairchild	Fairchild Semiconductor Corporation, Palo Alto, California
G. E.	General Electric Company, Semiconductor Division, Buffalo, New York

Good-All	Good-All Capacitor Division of TRW, Ogallala, Nebraska
IRC	International Resistance Company, Philadelphia, Pennsylvania
Littelfuse	Littelfuse Incorporated, Des Plaines, Illinois
Mallory	P. R. Mallory and Company, Indianapolis, Indiana
Mektron	California General Corporation Incorporated, Mektron Division, Chula Vista, California
Motorola	Motorola Semiconductor Products, Phoenix, Arizona
Richey	Richey Electronics Incorporated, Nashville, Tennessee
SEC	Southern Electronics Corporation, Burbank, California
Semtech	Semtech Corporation, Newbury Park, California
Sprague	Sprague Electric Company, North Adams, Massachusetts
Stackpole	Stackpole Carbon Company, Saint Mary's, Pennsylvania
TI	Texas Instruments, Incorporated, Dallas, Texas
TRW	TRW Electronics Incorporated, El Segundo, California

MATCHED OR PAIRED PARTS

Prior to ordering or replacing electronic components in the equipment, refer to the notes regarding matched or paired parts on the schematic diagrams in Section VIII.

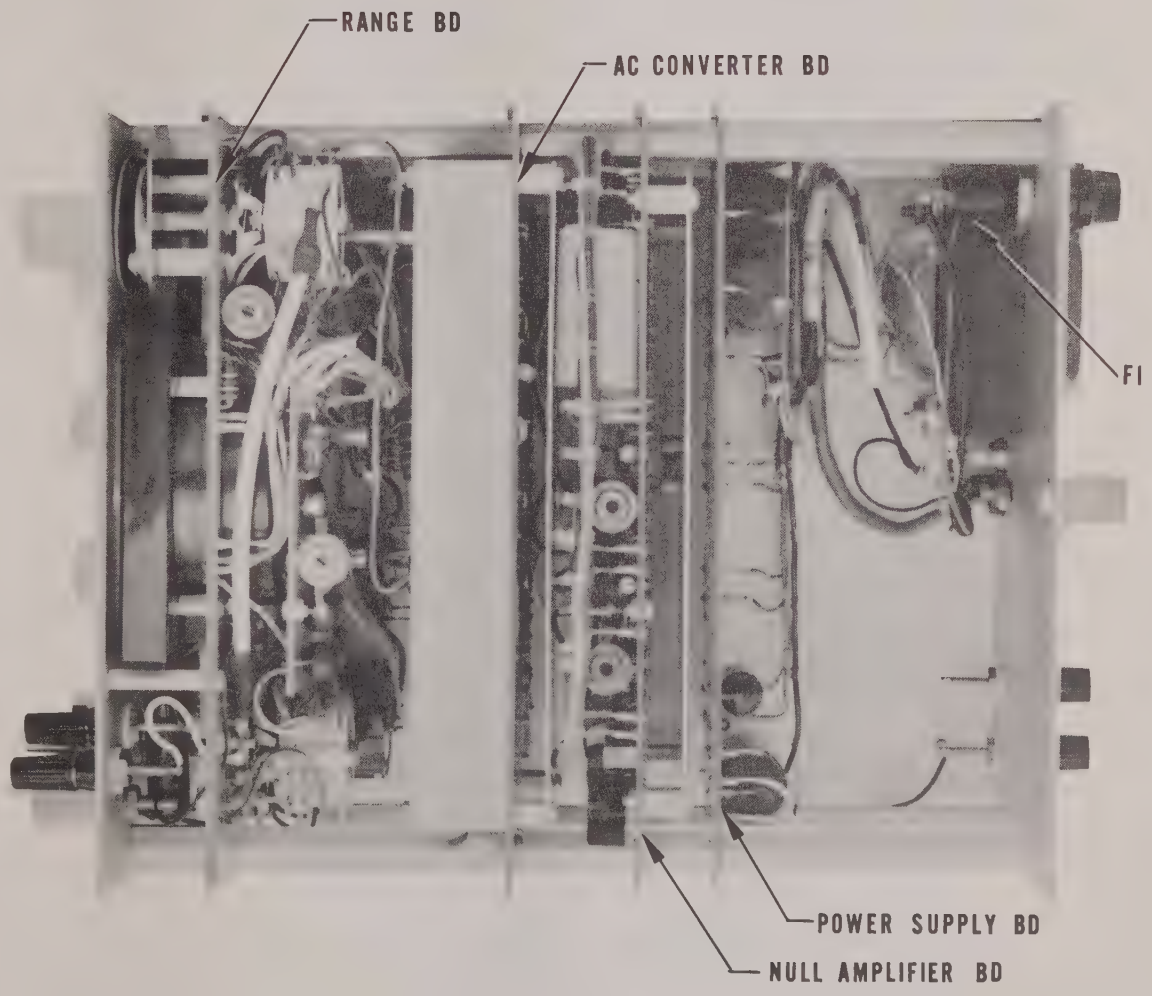
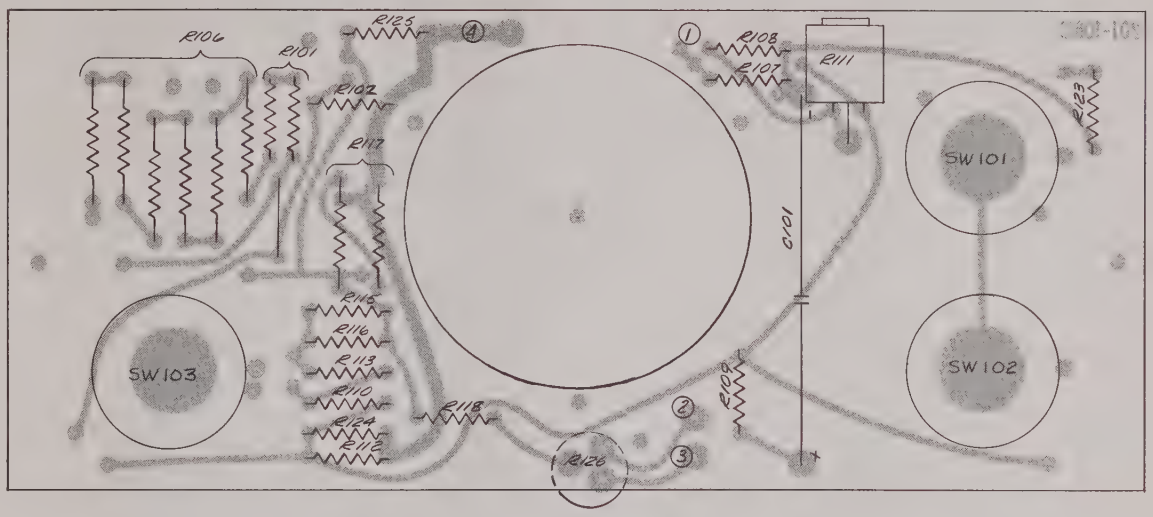


Figure 7-1

Chassis Assembly

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
	*--- -008	Range Board Assembly	1	Wavetek
	202-004	AC Converter Board Assembly (Model 202 and 204 Only)	1	Wavetek
	201-002	Null Amplifier Board Assembly (Model 201 and 202 Only)	1	Wavetek
	203-002	Null Amplifier Board Assembly (Model 203 and 204 Only)	1	Wavetek
	201-004	Power Supply Board Assembly (Model 201 and 203 Only)	1	Wavetek
	202-004	Power Supply Board Assembly (Model 202 and 204 Only)	1	Wavetek
F1	312.500	FUSE, 1/2 Amp, 3AG	1	Littlefuse
C1	10TM-S10	CAPACITOR, Mylar-Paper, 1000 v, 0.01 μf	1	Sprague
R1 thru R11	MK-3	RESISTOR, Wire Wound, 1/4 W, 0.01%, 1000 Ω	11	Mektron
R12 thru R22	MK-3	RESISTOR, Wire Wound, 1/4 W, 0.025%, 200 Ω	11	Mektron
R25 thru R35	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 200 Ω	11	Corning
R23	MK-3	RESISTOR, Wire Wound, 1/4 W, 0.025%, 502 Ω	1	Mektron
R24		RESISTOR, Trim, Carbon, 1/2 W (Selected Value)	1	
R36	5311-171-2	POTENTIOMETER, 400Ω	1	Beckman
	201-503	TRANSFORMER	1	Wavetek

*Same As Number of Machine It Occupies



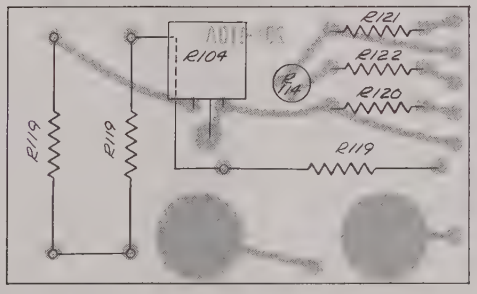


Figure 7-2

Range Board Assembly

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
	201-108D	CIRCUIT BOARD, 3/32 Glass Epoxy	1	Wavetek
	201-110A	CIRCUIT BOARD, 1/16 Glass Epoxy	1	Wavetek
R109	RC20GF220K	RESISTOR, Carbon, 1/2 W, 10%, 22Ω	1	Stackpole
R130	RC20GF151K	RESISTOR, Carbon, 1/2 W, 10%, 150Ω	1	Stackpole
R107	RC20GF241J	RESISTOR, Carbon, 1/2 W, 5%, 240Ω	1	Stackpole
R108	RC20GF471K	RESISTOR, Carbon, 1/2 W, 10%, 470Ω	1	Stackpole
R123	RC20GF751J	RESISTOR, Carbon, 1/2 W, 5%, 750Ω	1	Stackpole
R105	RC20GF273K	RESISTOR, Carbon, 1/2 W, 10%, 27,000Ω	1	Stackpole
R118	RC20GF473K	RESISTOR, Carbon, 1/2 W, 10%, 47,000Ω	1	Stackpole
R102	RC20GF105K	RESISTOR, Carbon, 1/2 W, 10%, 10,000,000Ω	1	Stackpole
R115, R116	C5	RESISTOR, Metal Film, 1/4 W, 1%, 10Ω	2	Corning
R129	C5	RESISTOR, Metal Film, 1/4 W, 1%, 12.4Ω	2	Corning
R113	C5	RESISTOR, Metal Film, 1/4 W, 1%, 49.9Ω	1	Corning
R112	C5	RESISTOR, Metal Film, 1/4 W, 1%, 316Ω	1	Corning
R110	C5	RESISTOR, Metal Film, 1/4 W, 1%, 499Ω	1	Corning
R124	C5	RESISTOR, Metal Film, 1/4 W, 1%, 1000Ω	1	Corning

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R102	C5	RESISTOR, Metal Film, 1/4 W, 1%, 110,000Ω	1	Corning
R101	C5	RESISTOR, Metal Film, 1/4 W, 1%, 422,000Ω	2	Corning
R106	CEC-TO	RESISTOR, Metal Film, 1/2 W, 1%, 1,500,000Ω	6	IRC
R117	BWH20	RESISTOR, Wire Wound, 1 W, 5%, 0.27Ω	2	IRC
R121	MK-3	RESISTOR, Wire Wound, 1/4 W, 0.01%, 1111.1Ω	1	Mektron
R122	MK-3	RESISTOR, Wire Wound, 1/4 W, 0.025%, 8995Ω	1	Mektron
R120	MK-3	RESISTOR, Wire Wound, 1/4 W, 0.025%, 100,050Ω	1	Mektron
R119	MK-3	RESISTOR, Wire Wound, 3/4 W, 0.025%, 3,300,000Ω	3	Mektron
R125		RESISTOR, Trim, Selected Value	1	
R114	62PR10	POTENTIOMETER, 10Ω	1	Beckman
R104, R111	FR103M	POTENTIOMETER, 10,000Ω	2	Allen-Bradley
R126	FR104M	POTENTIOMETER, 100,000Ω	1	Allen-Bradley
C101	34-750-1760-6T	CAPACITOR, Electrolytic, 6 v, 1750 μf	1	Richey
SW101		SWITCH, Assembly	1	Wavetek
SW102		SWITCH, Assembly	1	Wavetek
SW103		SWITCH, Assembly	1	Wavetek
M1	MM6607-2A	METER	1	Wavetek

Note: Not all of above parts are used on an individual model range board. See range board schematic.

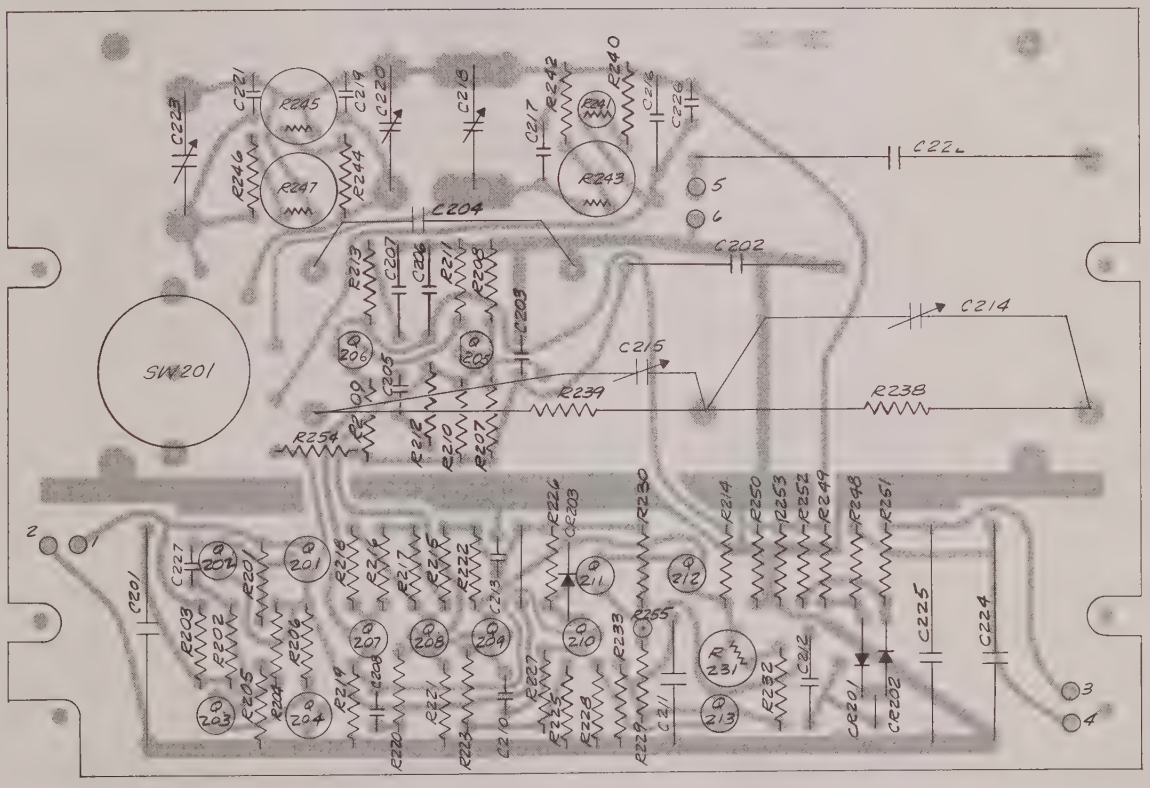


Figure 7-3

AC Converter Board Assembly

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R254	RC20GF100K	RESISTOR, Carbon, 1/2 W, 10%, 10Ω	1	Stackpole
R218	RC20GF150K	RESISTOR, Carbon, 1/2 W, 10%, 15Ω	1	Stackpole
R216, R217, R223, R227	RC20GF470K	RESISTOR, Carbon, 1/2 W, 10%, 47Ω	4	Stackpole
R228	RC20GF101K	RESISTOR, Carbon, 1/2 W, 10%, 100Ω	1	Stackpole
R220	RC20GF121K	RESISTOR, Carbon, 1/2 W, 10%, 120Ω	1	Stackpole
R225	RC20GF221K	RESISTOR, Carbon, 1/2 W, 10%, 220Ω	1	Stackpole
R212, R215	RC20GF271K	RESISTOR, Carbon, 1/2 W, 10%, 270Ω	2	Stackpole
R209, R210, R232	RC20GF471K	RESISTOR, Carbon, 1/2 W, 10%, 470Ω	3	Stackpole
R233	RC20GF561K	RESISTOR, Carbon, 1/2 W, 10%, 560Ω	1	Stackpole
R219, R221, R222, R226, R255	RC20GF102K	RESISTOR, Carbon, 1/2 W, 10%, 1000Ω	5	Stackpole
R211	RC20GF910J	RESISTOR, Carbon, 1/2 W, 5%, 910Ω	1	Stackpole
R204	RC20GF332K	RESISTOR, Carbon, 1/2 W, 10%, 3300Ω	1	Stackpole
R205, R206	RC20GF472K	RESISTOR, Carbon, 1/2 W, 10%, 4700Ω	2	Stackpole
R201	RC20GF103K	RESISTOR, Carbon, 1/2 W, 10%, 10,000Ω	1	Stackpole
R202, R203	RC20GF273K	RESISTOR, Carbon, 1/2 W, 10%, 27,000Ω	2	Stackpole
R229	RC20GF473K	RESISTOR, Carbon, 1/2 W, 10%, 47,000Ω	1	Stackpole

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R213	RC20GF104K	RESISTOR, Carbon, 1/2 W, 10%, 100,000Ω	1	Stackpole
R214	RC20GF155K	RESISTOR, Carbon, 1/2 W, 10%, 1,500,000Ω	1	Stackpole
R207, R208	RC20GF275K	RESISTOR, Carbon, 1/2 W, 10%, 2,700,000Ω	2	Stackpole
R230		RESISTOR, Carbon, 1/2 W, 10%, Trim	1	Stackpole
R250	MEA T-2	RESISTOR, Metal Film, 1/4 W, 1%, 100Ω	1	IRC
R240	MEA T-2	RESISTOR, Metal Film, 1/4 W, 1%, 110Ω	1	IRC
R249, R252	MEA T-2	RESISTOR, Metal Film, 1/4 W, 1%, 499Ω	2	IRC
R253	MEA T-0	RESISTOR, Metal Film, 1/4 W, 1%, 1500Ω	1	IRC
R242	MEA T-2	RESISTOR, Metal Film, 1/4 W, 1%, 1910Ω	1	IRC
R244	MEA T-2	RESISTOR, Metal Film, 1/4 W, 1%, 20,000Ω	1	IRC
R248, R251	CEA T-0	RESISTOR, Metal Film, 1/4 W, 1%, 48,700Ω	2	IRC
R246	MEA T-2	RESISTOR, Metal Film, 1/4 W, 1%, 200,000Ω	1	IRC
R238, R239	MEH T-2	RESISTOR, Metal Film, 2 W, 1%, 500,000Ω	2	IRC
R241	62PR10	POTENTIOMETER, 10Ω	1	Beckman
R243	FR101M	POTENTIOMETER, 100Ω	1	Allen-Bradley
R245	FR102M	POTENTIOMETER, 1000Ω	1	Allen-Bradley

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R231	FR252M	POTENTIOMETER, 2500Ω	1	Allen-Bradley
R247	FR103M	POTENTIOMETER, 10,000Ω	1	Allen-Bradley
C223	822EZ	CAPACITOR, Variable, 1.5 - 7 pf	1	CRL
C220	423	CAPACITOR, Variable, 7 - 100 pf	1	Arco
C214, C215	565-013	CAPACITOR, Variable, 8 - 12 pf	2	Erie
C218	469	CAPACITOR, Variable, 170 - 780 pf	1	Arco
C221	DM-15-100J	CAPACITOR, Silver Mica, 5%, 10 pf	1	Arco
C210	DD470	CAPACITOR, Ceramic, 1000 v, 10%, 47 pf	1	CRL
C219	DM-15-151F	CAPACITOR, Silver Mica, 1%, 150 pf	1	Arco
C208	DD152	CAPACITOR, Ceramic, 1000 v, 10%, 1500 pf	1	CRL
C217	DM-15-152F	CAPACITOR, Silver Mica, 1%, 1500 pf	1	Arco
C227	DD391	CAPACITOR, Ceramic, 1000 v, 10%, 390 pf	1	CRL
C211	192P22392	CAPACITOR, Mylar, 200 v, 10%, 0.022 μf	1	Sprague
C216	PVC1147	CAPACITOR, Mylar, 100 v, 10%, 0.047 μf	1	Mallory
C203, C213	UK10-104	CAPACITOR, Ceramic, 10 v, 0.1 μf	2	CRL
C222	MO504-L1	CAPACITOR, Mylar, 1000 v, 0.5 μf	1	SEC

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
C204, C224, C225	X663F	CAPACITOR, Mylar, 200 v, 10%, 2 μf	3	Good-All
C206	150D	CAPACITOR, Tantalum, 35 v, 5.6 μf	1	Sprague
C207	150D	CAPACITOR, Tantalum, 20 v, 10 μf	1	Sprague
C212	150D	CAPACITOR, Tantalum, 10 v, 33 μf	1	Sprague
C201, C202	EA15-250	CAPACITOR, Electrolytic, 15 v, 250 μf	2	CRL
C205	DD221	CAPACITOR, Ceramic, 1000 v, 10%, 220 pf	1	CRL
CR201, CR202, CR203	FD6666	DIODES	3	Fairchild
Q209, Q210, Q213	2N3563	TRANSISTORS	3	Fairchild
Q202, Q203	2N3565	TRANSISTORS	2	Fairchild
Q201, Q204	2N3638	TRANSISTORS	2	Fairchild
Q205, Q206	2N3819	TRANSISTORS, Matched Pair	1	TI
Q207, Q208, Q211, Q212	2N3905	TRANSISTORS	4	Motorola
SW201	T106	WAFER, 2 pole, 5 position	1	CTS
C226		CAPACITOR, TRIM	1	
	204-104C	CIRCUIT BOARD, 1/16 Glass Epoxy	1	Wavetek

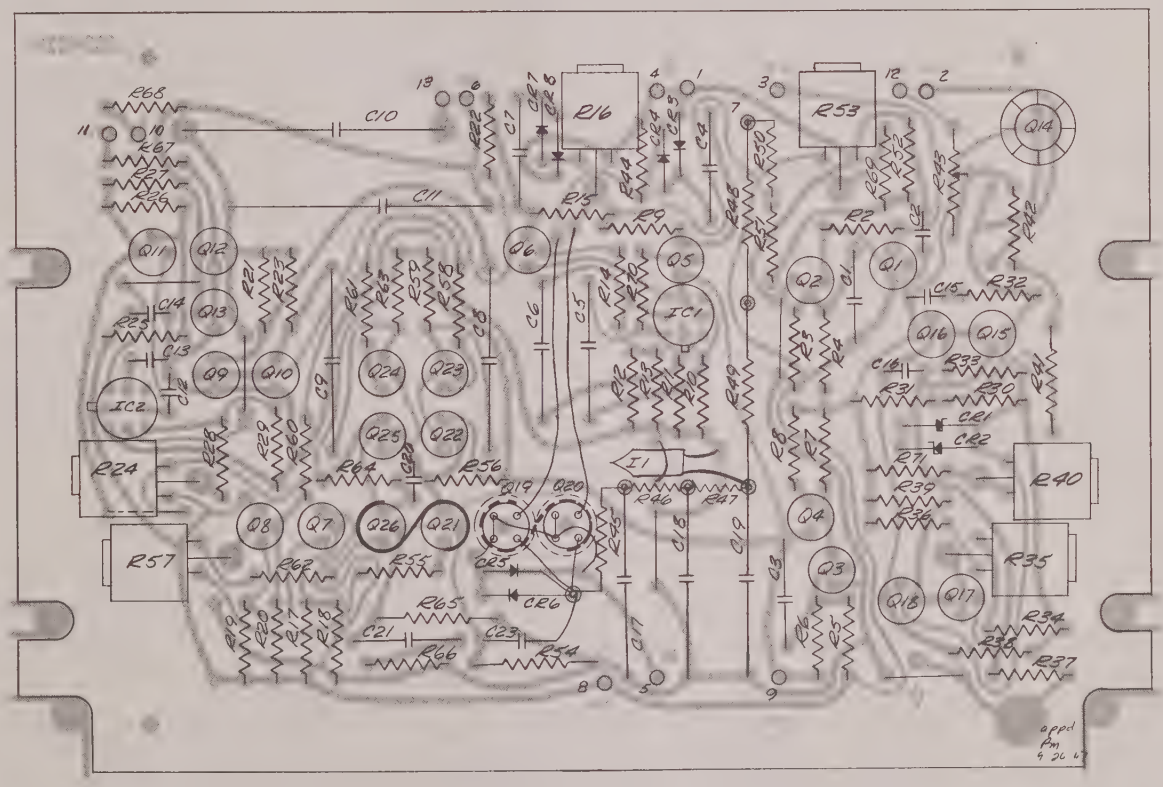


Figure 7-5
Null Amplifier Board Assembly

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R52	RC20GF100K	RESISTOR, Carbon, 1/2 W, 10%, 10Ω	1	Stackpole
R58, R61	RC20GF470K	RESISTOR, Carbon, 1/2 W, 10%, 47Ω	2	Stackpole
R12	RC20GF331K	RESISTOR, Carbon, 1/2 W, 10%, 330Ω	1	Stackpole
R8	RC20GF391K	RESISTOR, Carbon, 1/2 W, 10%, 390Ω	1	Stackpole
R32	RC20GF821K	RESISTOR, Carbon, 1/2 W, 10%, 820Ω	1	Stackpole
R17, R18, R20, R60	RC20GF222K	RESISTOR, Carbon, 1/2 W, 10%, 2200Ω	4	Stackpole
R2	RC20GF392K	RESISTOR, Carbon, 1/2 W, 10%, 3900Ω	1	Stackpole
R7, R9, R14, R15, R22, R59, R63, R67, R68, R70	RC20GF472K	RESISTOR, Carbon, 1/2 W, 10%, 4700Ω	10	Stackpole
R39	RC20GF682K	RESISTOR, Carbon, 1/2 W, 10%, 6800Ω	1	Stackpole
R27, R29	RC20GF103K	RESISTOR, Carbon, 1/2 W, 10%, 10,000Ω	2	Stackpole
R33	RC20GF153K	RESISTOR, Carbon, 1/2 W, 10%, 15,000Ω	1	Stackpole
R21, R23	RC20GF223K	RESISTOR, Carbon, 1/2 W, 10%, 22,000Ω	2	Stackpole
R37, R38	RC20GF273K	RESISTOR, Carbon, 1/2 W, 10%, 27,000Ω	2	Stackpole
R19	RC20GF563K	RESISTOR, Carbon, 1/2 W, 10%, 56,000Ω	1	Stackpole
R31, R44	RC20GF104K	RESISTOR, Carbon, 1/2 W, 10%, 100,000Ω	2	Stackpole

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R69	RC20GF274K	RESISTOR, Carbon, 1/2 W, 10%, 270,000Ω	1	Stackpole
R50, R51	RC20GF564J	RESISTOR, Carbon, 1/2 W, 5%, 560,000Ω	2	Stackpole
R30	RC20GF105K	RESISTOR, Carbon, 1/2 W, 10%, 1,000,000Ω	1	Stackpole
R28	RC20GF224K	RESISTOR, Carbon, 1/2 W, 10%, 2,200,000Ω	1	Stackpole
R46, R47	RC20GF274K	RESISTOR, Carbon, 1/4 W, 10%, 270,000Ω	2	Stackpole
R48, R49	RC20GF154K	RESISTOR, Carbon, 2 W, 10%, 150,000Ω	2	Stackpole
R71	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 453Ω (499Ω Model 205, 206 only)	1	Corning
R26	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 2,490Ω	1	Corning
R36	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 3,160Ω	1	Corning
R3, R55, R62	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 4,640Ω	3	Corning
R6	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 5,760Ω	1	Corning
R5	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 6,980Ω	1	Corning
R25	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 10,000Ω	1	Corning
R34	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 12,100Ω	1	Corning
R4	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 15,000Ω	1	Corning
R10, R11	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 21,500Ω	2	Corning

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R45, R56, R64, R66	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 464,000Ω	4	Corning
R54, R65	RN60D	RESISTOR, Metal Film, 1/2 W, 1%, 1,500,000Ω	2	Corning
R13		RESISTOR, Trim, Carbon	1	
R41*		RESISTOR, Trim, Metal Film, 1/4 W, 1%	1	
R42*		RESISTOR, Trim, Wire Wound, 0.1%	1	
R43*	78PR20	POTENTIOMETER, 20Ω	1	Beckman
R40*	FR101M	POTENTIOMETER, 100Ω	1	Allen-Bradley
R35, R57	FR252M	POTENTIOMETER, 2,500Ω	2	Allen-Bradley
R16, R24, R53	FR104M	POTENTIOMETER, 100,000Ω	3	Allen-Bradley
C20	DD101	CAPACITOR, Ceramic, 1000 v, 100 pf	1	CRL
C15, C16	CK103	CAPACITOR, Ceramic, 50 v, 0.01 μf	2	CRL
C1, C3, C21	WMFISI	CAPACITOR, Mylar, 100 v, 0.01 μf	3	CDE
C2, C12, C13, C14	UK10-104	CAPACITOR, Ceramic, 10 v, 0.1 μf	4	CRL
C8, C9	WMFIS47	CAPACITOR, Mylar, 100 v, 0.047 μf	2	CDE
C5, C6	X633F	CAPACITOR, Mylar, Matched pair, 200 v, 0.33 μf	1	TRW
C17, C18, C19	POLO4-L1	CAPACITOR, Polystyrene, 100 v, 0.1 μf	3	SEC

* Omit For Models 205 and 206.

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
C11	MD1A105	CAPACITOR, Mylar, 100 v, 1 μf	1	Elpac
C23	X633F	CAPACITOR, Mylar, 0.01 μf	1	TRW
C10	X633F	CAPACITOR, Mylar, 200 v, 4 μf	1	TRW
C4, C7	150D	CAPACITOR, Tantalum, 35 v, 5.6 μf	2	Sprague
Q14	2N3299	TRANSISTOR	1	Fairchild
Q2, Q9, Q13, Q17, Q18	2N3565	TRANSISTOR	5	Fairchild
Q3, Q4, Q7, Q8, Q11, Q12, Q15, Q16, Q23, Q24	2N3638	TRANSISTOR	10	Fairchild
Q1, Q5, Q6	2N3642	TRANSISTOR	3	Fairchild
Q10, Q22, Q25	2N4248	TRANSISTOR	3	Fairchild
Q19	2N4351	TRANSISTOR	1	Motorola
Q20	2N4352	TRANSISTOR	1	Motorola
Q21, Q26	2N4250	TRANSISTOR, Matched Pair	1	Fairchild
CR3, CR4, CR5, CR6, CR7, CR8	FD6666	DIODE	6	Fairchild
CR1, CR2	DT50920	DIODE, Zener, Matched Pair	1	Dickson
IC1	μL914	INTEGRATED CIRCUIT	1	Fairchild
IC2	μA702C	INTEGRATED CIRCUIT, Amplifier	1	Fairchild
I1	NE2P	INDICATOR LAMP, Neon	1	Eldema
	203-102B	CIRCUIT BOARD, 1/16 Glass Epoxy	1	Wavetek

Null Amplifier Board Assembly, Parts List

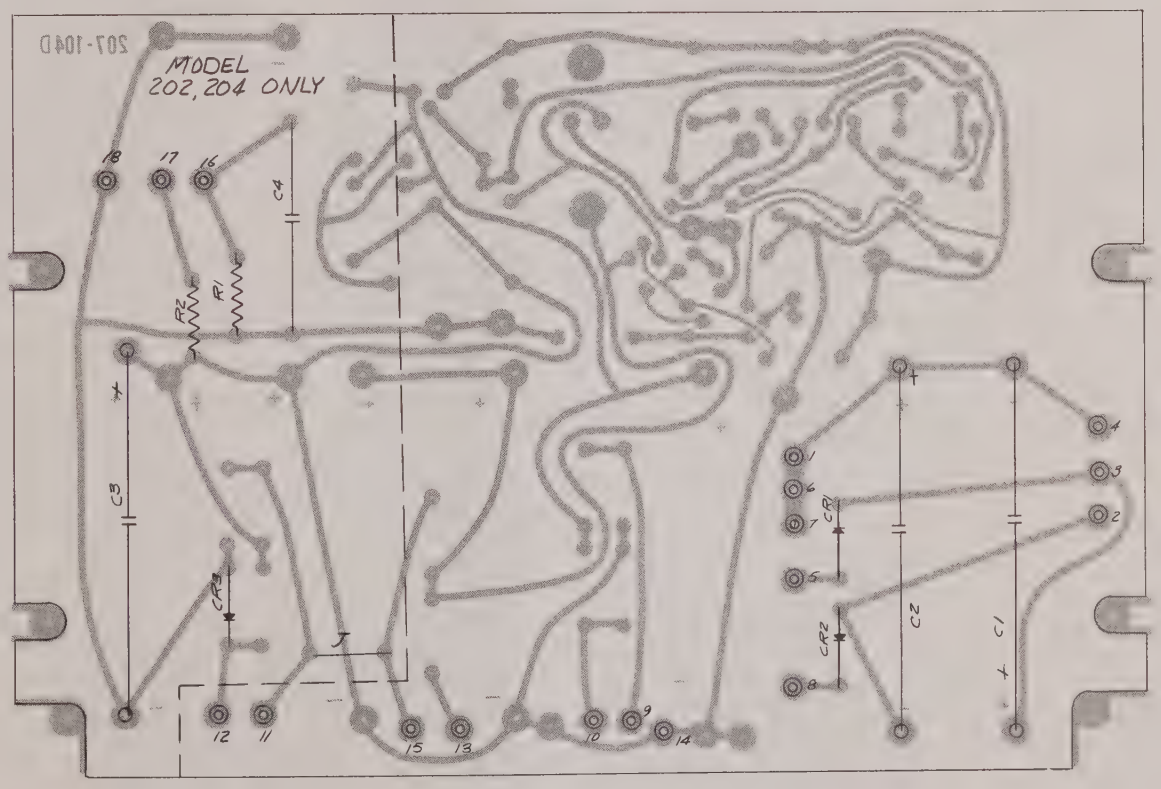
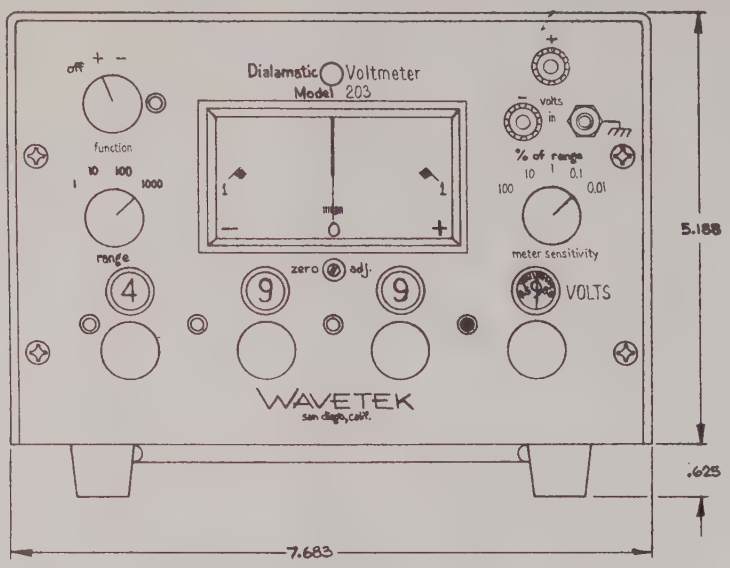


Figure 7-6
Power Supply Board Assembly

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
C1, C2	34-750-1000-35T	CAPACITOR, Electrolytic, 1000 μf, 35v	2	Richey
CR1, CR2	SCE-1	DIODE	2	Semtech
	207-104D	CIRCUIT BOARD, 1/16 Glass Epoxy	1	Wavetek
Note:	These Components For 202 and 204 Only.			
R2	RC20GF470K	RESISTOR, Carbon, 1/2 W, 10%, 47Ω	1	Stackpole
R1	RC20GF106K	RESISTOR, Carbon, 1/2 W, 10%, 10,000,000Ω	1	Stackpole
C4	10TM-S10	CAPACITOR, Mylar-Paper, 1000 v, 0.01 μf	1	Sprague
C3	34-750-1000-25T	CAPACITOR, Electro-	1	Richey
CR1 CR2 CR3	SCE-1	DIODE	3	Semtech

SECTION VIII
SCHEMATIC DIAGRAMS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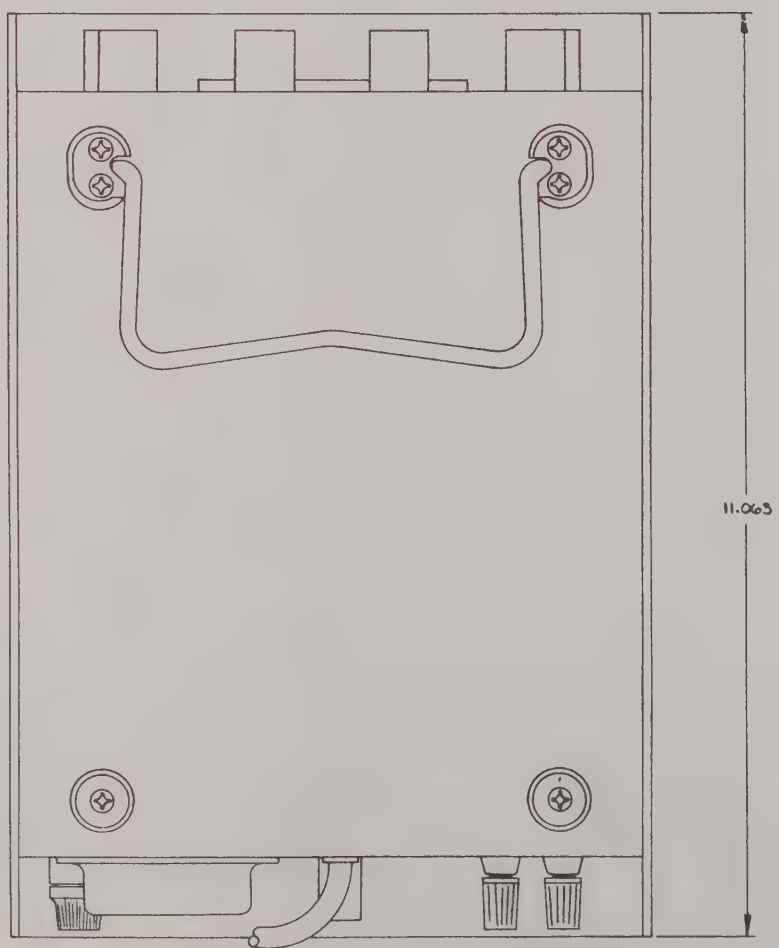
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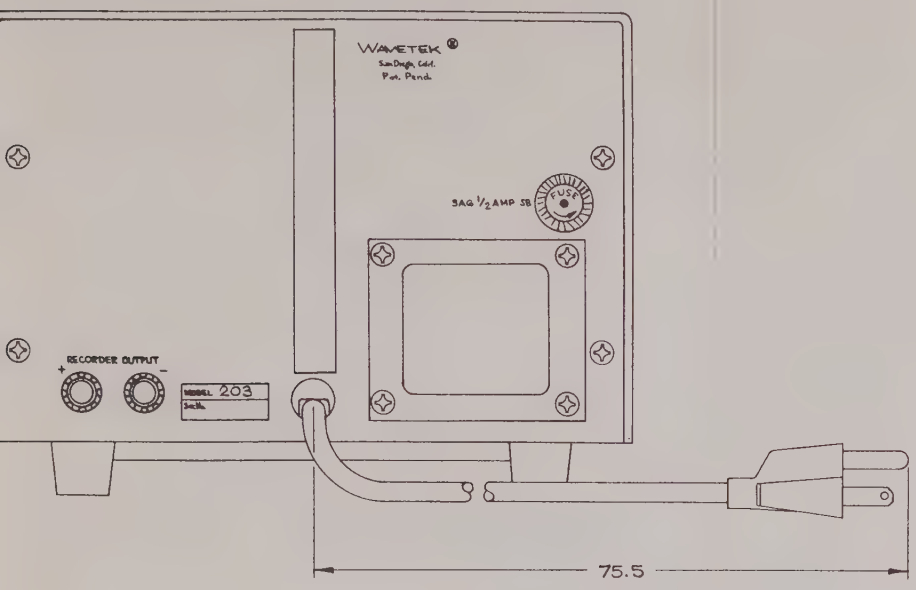

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finish N/A	model no 203	dwg no 203-601	rev		

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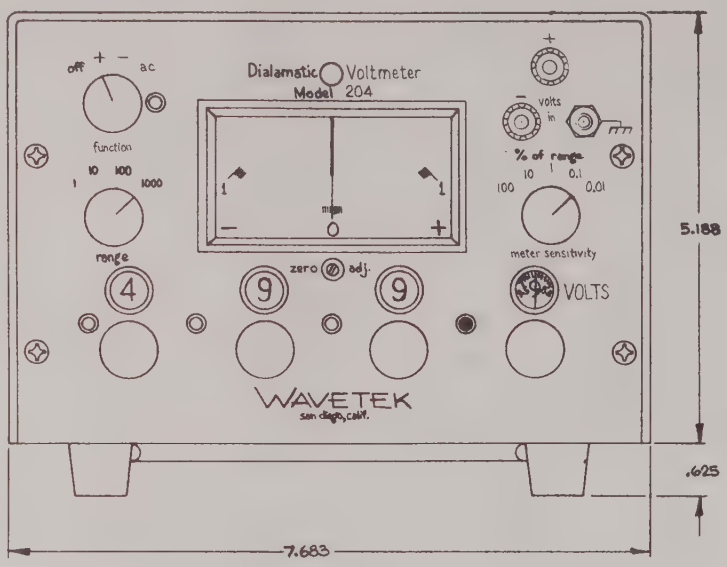
Dialamatic Voltmeter
Model 204
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% of range
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VOLTS
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san diego, calif.
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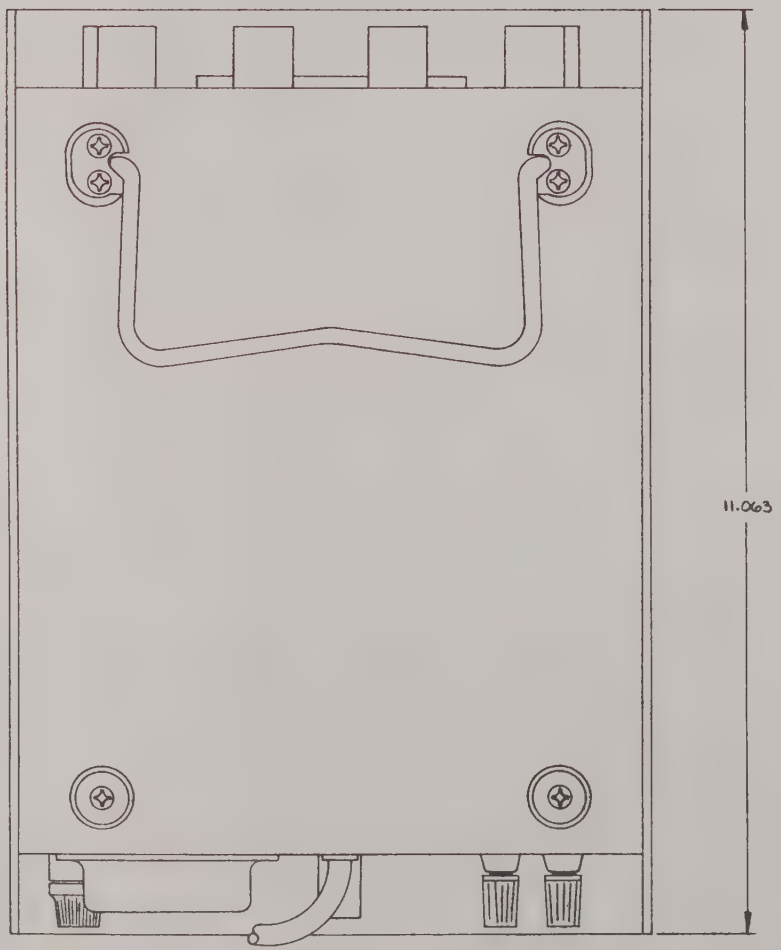
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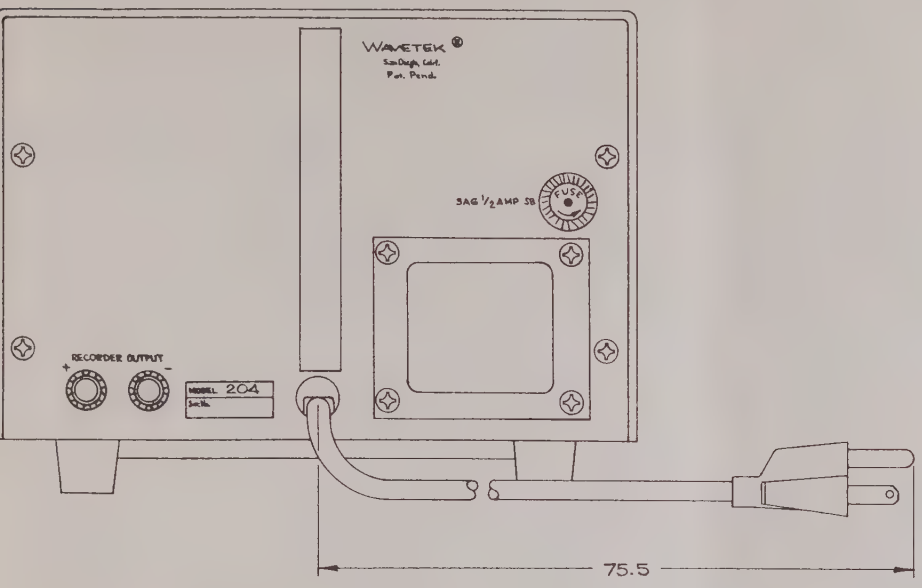

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material N/A	title OUTLINE DRAWING				
finish N/A	model no. 204	dwg no 204-601	rev		

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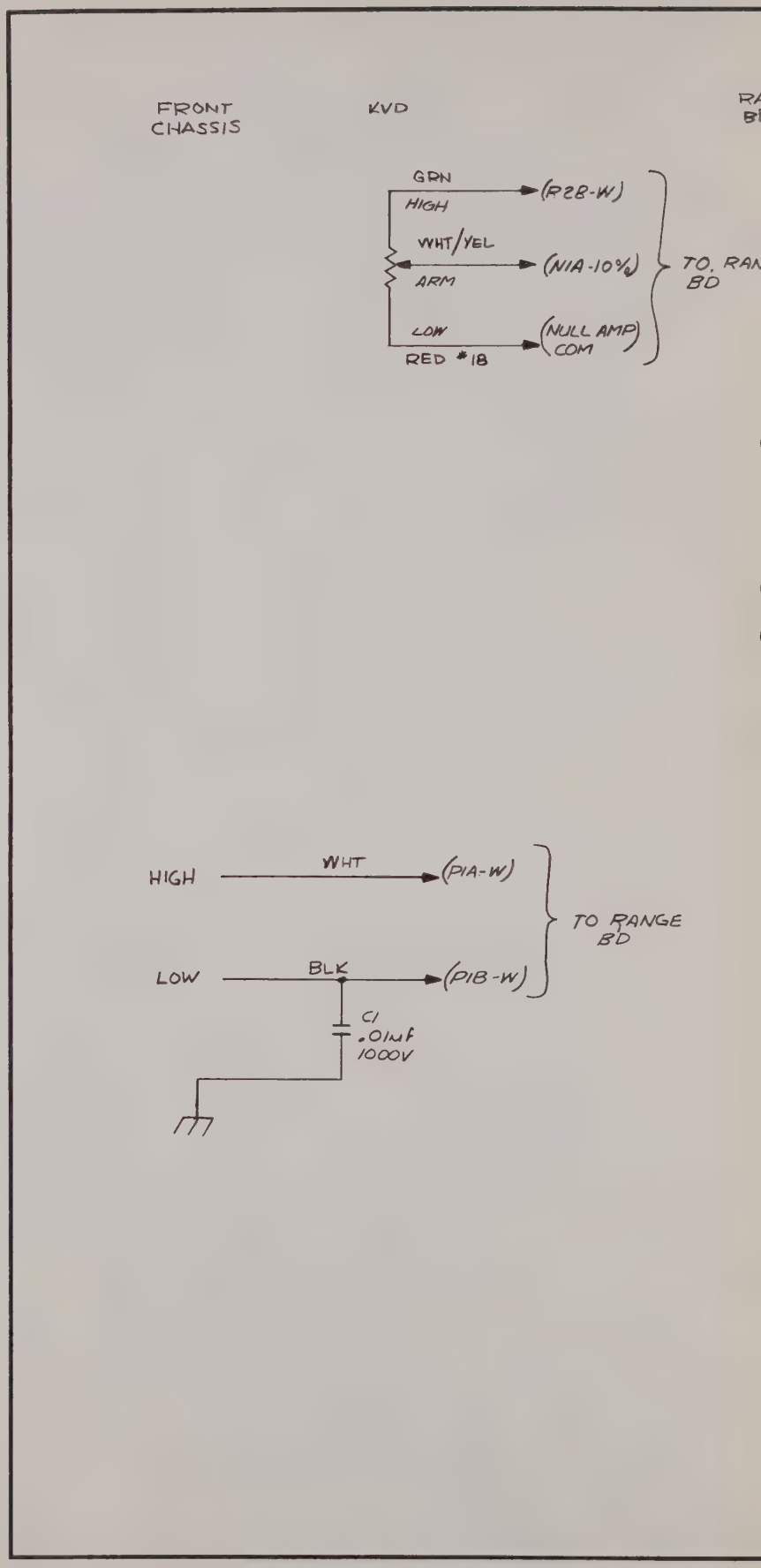
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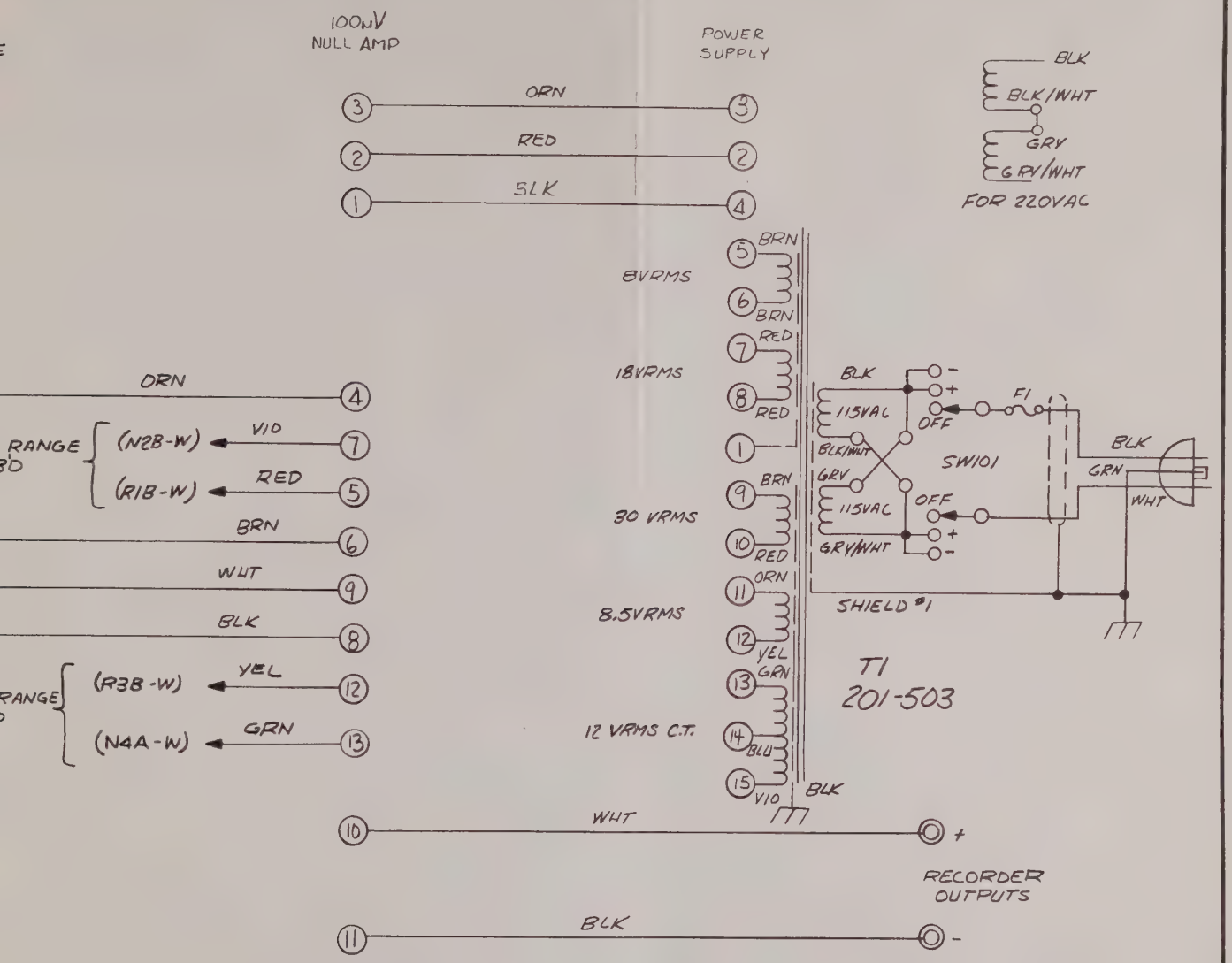

tolerance unless otherwise specified	rev	ecn	by	date	app.
.XXX ± .010 .XX ± .030	WAVETEK san diego, calif				
scale N/A	by MBachich	date 10/9/67	app. Pm		
material N/A	title SCHEMATIC, CHASSIS				
finish N/A	model no. 203	dwg no. 203-200	rev		

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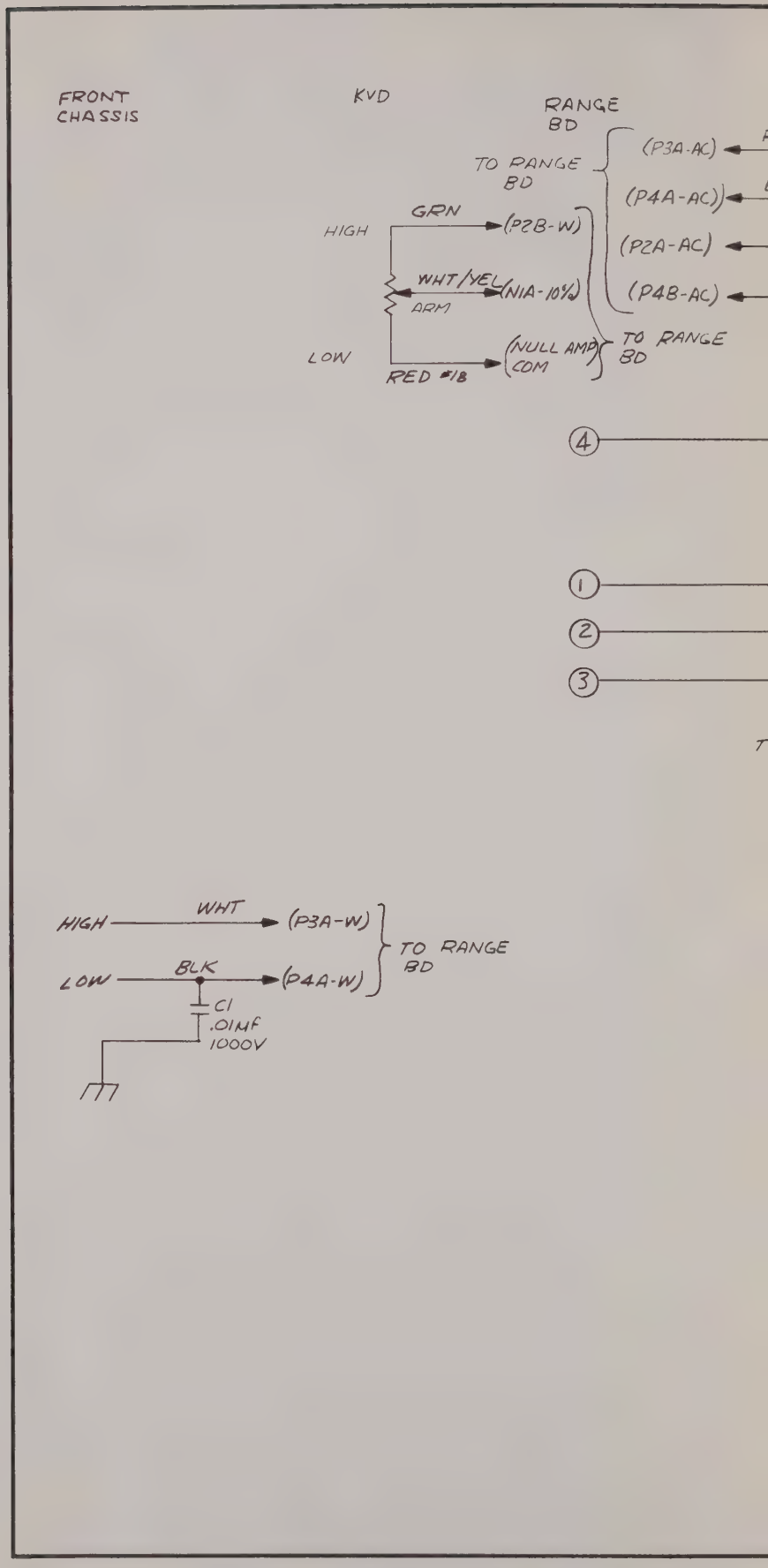
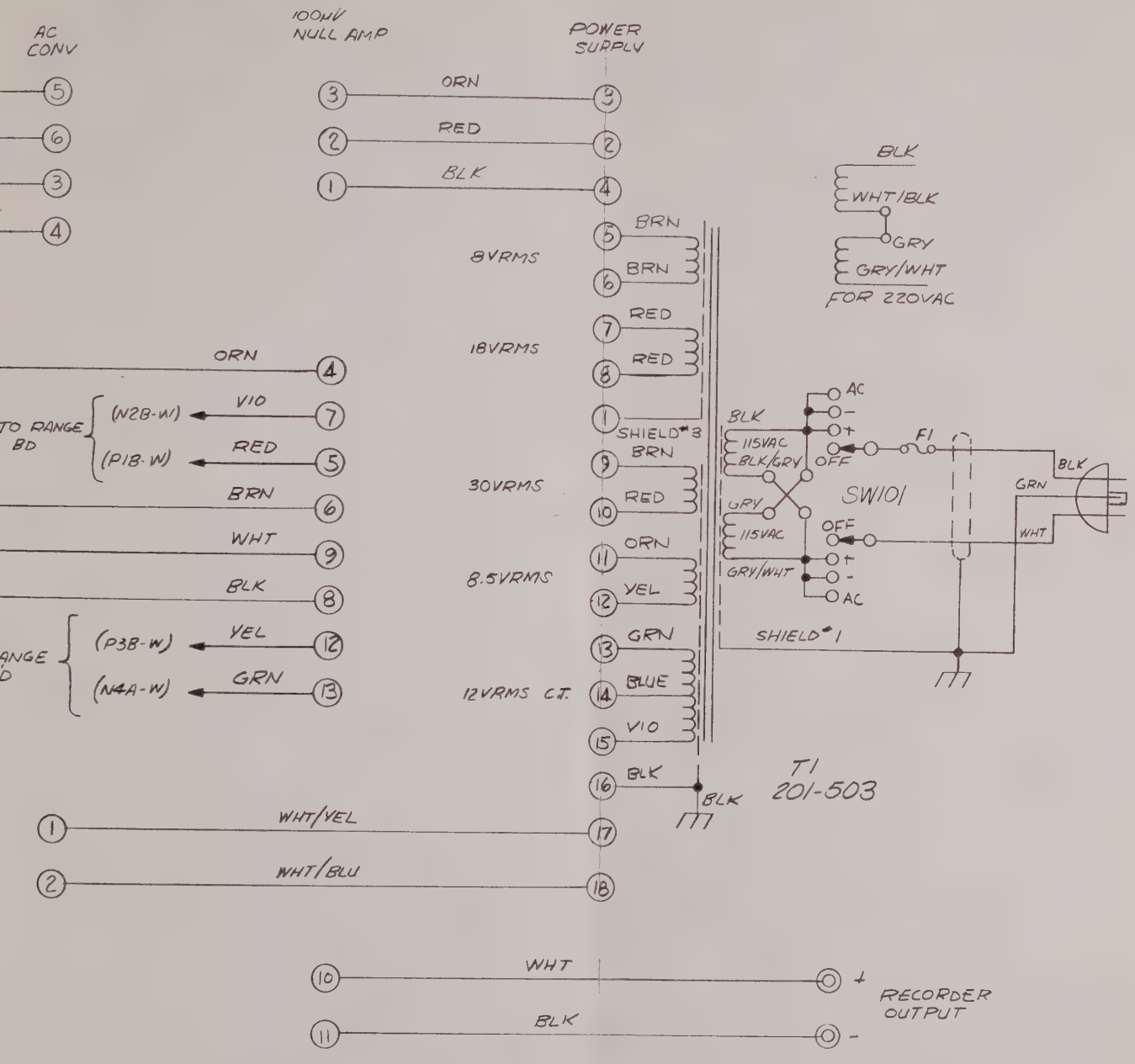

FRONT CHASSIS
KVD
RANGE BD
TO RANGE BD
(P3A-AC)
(P4A-AC)
(P2A-AC)
(P4B-AC)
HIGH
GRN
(P2B-W)
WHT/YEL
(N1A-10%)
ARM
LOW
RED #18
(NULL AMP COM)
TO RANGE BD
4
1
2
3
HIGH
WHT
(P3A-W)
LOW
BLK
(P4A-W)
TO RANGE BD
C1
.01MF
1000V



tolerance unless otherwise specified	rev	ecn	by	date	app.
.XXX ± .010 .XX ± .030	WAVETEK san diego, calif				
scale N/A	by M Bechtholdt	date 10/10/67	app. Rm		
material N/A	title SCHEMATIC, CHASSIS				
finish N/A	model no. 204	dwg no. 204-200	rev		

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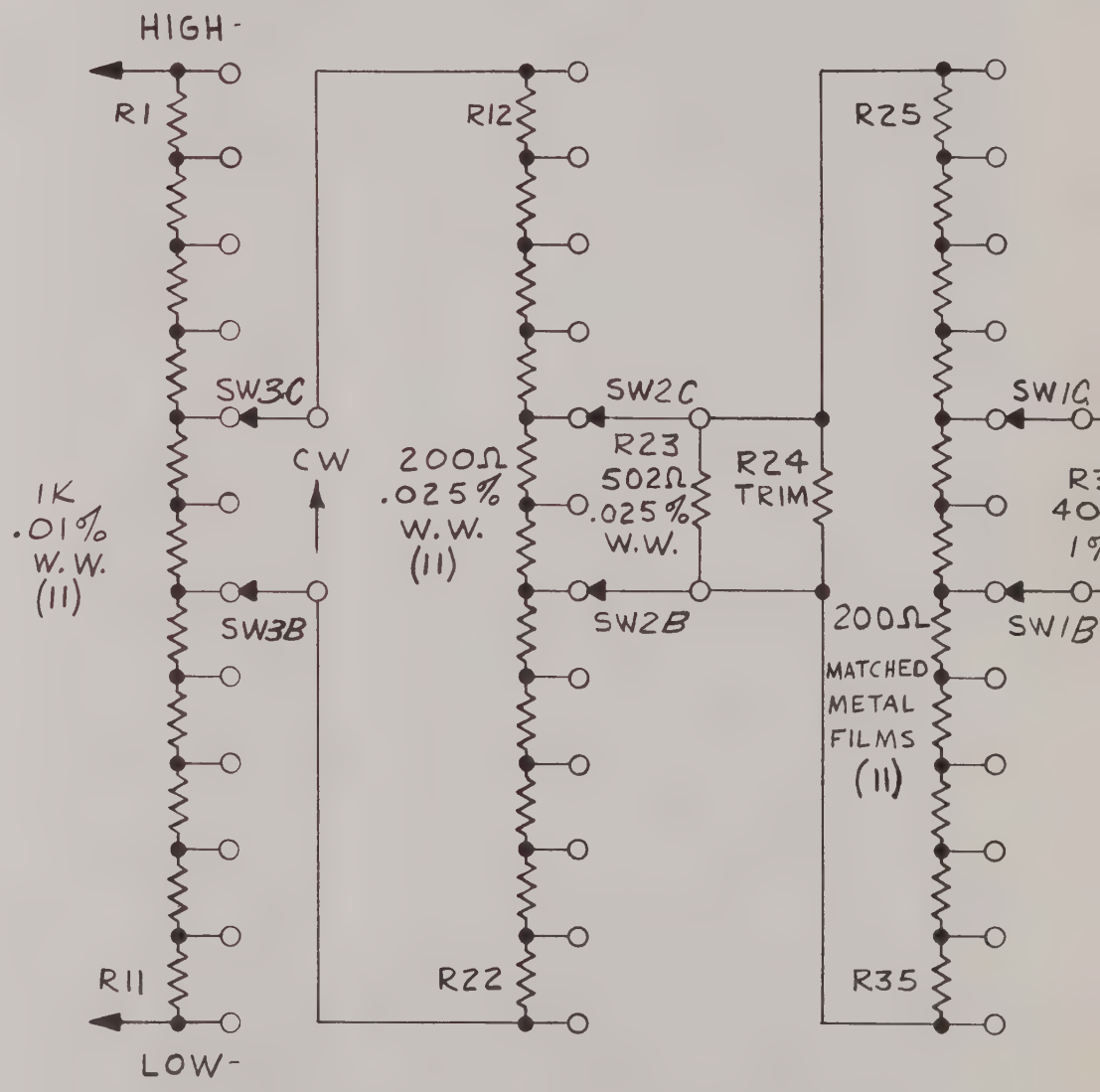
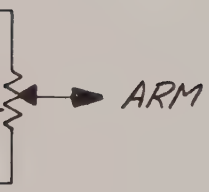

HIGH-
R1
R12
R25
SW3C
SW2C
SW1C
CW
200Ω
.025%
W.W.
(11)
R23
502Ω
.025%
W.W.
R24
TRIM
1K
.01%
W.W.
(11)
SW3B
SW2B
SW1B
200Ω
MATCHED
METAL
FILMS
(11)
R11
R22
R35
LOW-



CHG	ECN NO.	BY	DATE	APP.
B	—	MB.	10/6/67	
A		S.L.B.	10-31-66	

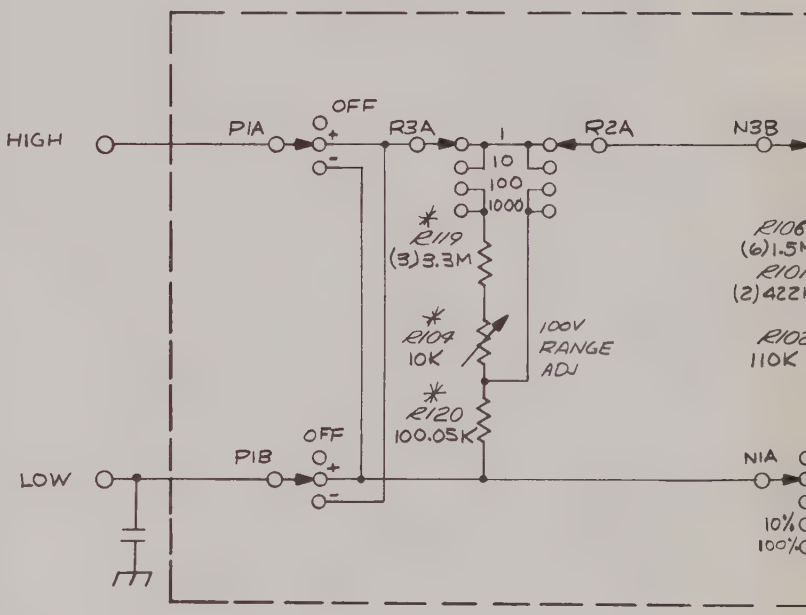
WAVETEK 8159 ENGINEER RD SAN DIEGO, CALIF

DWN: DATE: 9-15-66 APPD

KELVIN-VARLEY DIVIDER

MODEL 201-204, 207, 701+702

200-200B



NOTES

1/ INDICATES CHASSIS GROUND

2 SWITCH NOMENCLATURE

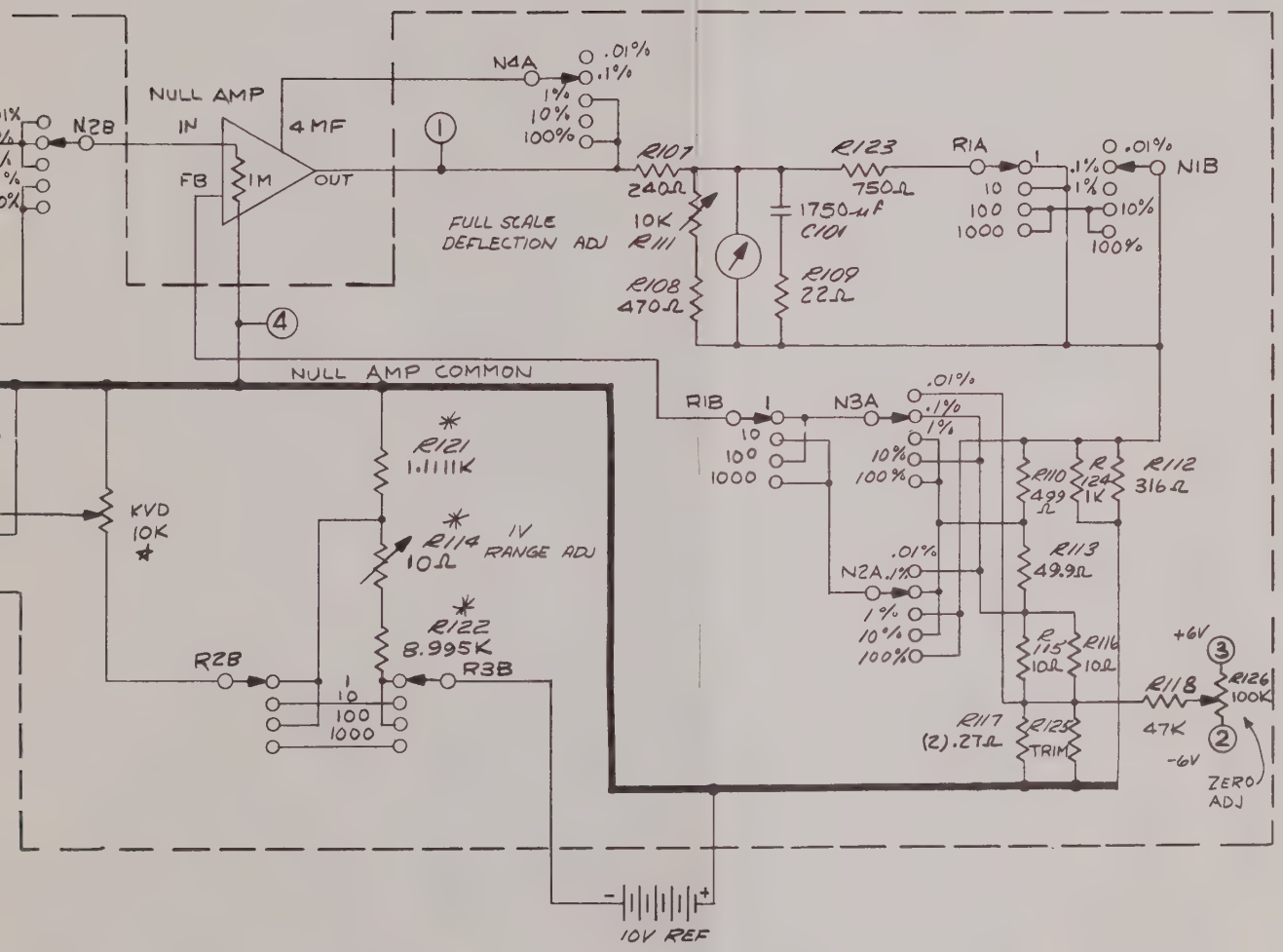
a: FIRST LETTER INDICATES SWITCH FUNCTION(N-NO
R- RANGE SW102, P- POLARITY SW101)

b: NUMBER INDICATES WAFER LOCATION (1 IS WAFER CLOS
TO FRONT PANEL)

C: SECOND LETTER INDICATES SWITCH POLE (A INDICATI
AS VIEWED FROM FRONT)

3.* LOCATED ON BOARD 201-010A ONLY.

4 * SCHEMATIC 200-2008



SENSITIVITY, SW103,

LEFT POLE

tolerance unless otherwise specified	rev	ecn	by	date	app.
.XXX ± .010 .XX ± .030	WAVETEK san diego, calif				
scale N/A	by MEB	date 9-5-67	app. Bm		
material N/A	title SCHEMATIC RANGE BD				
finish N/A	model no. 203	dwg no. 203-208	rev A		

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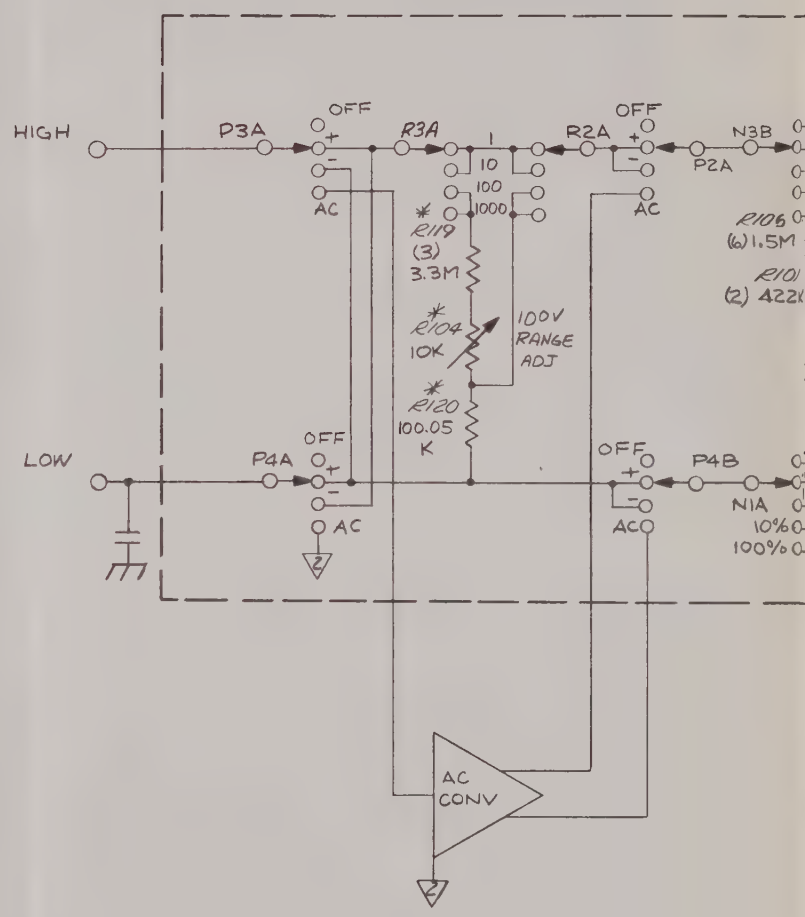


NOTES: UNLESS OTHERWISE SPECIFIED

1 ⏚ INDICATES CHASSIS GROUND

2 ▽ AC CONVERTER COMMON

3 SWITCH NOMENCLATURE:

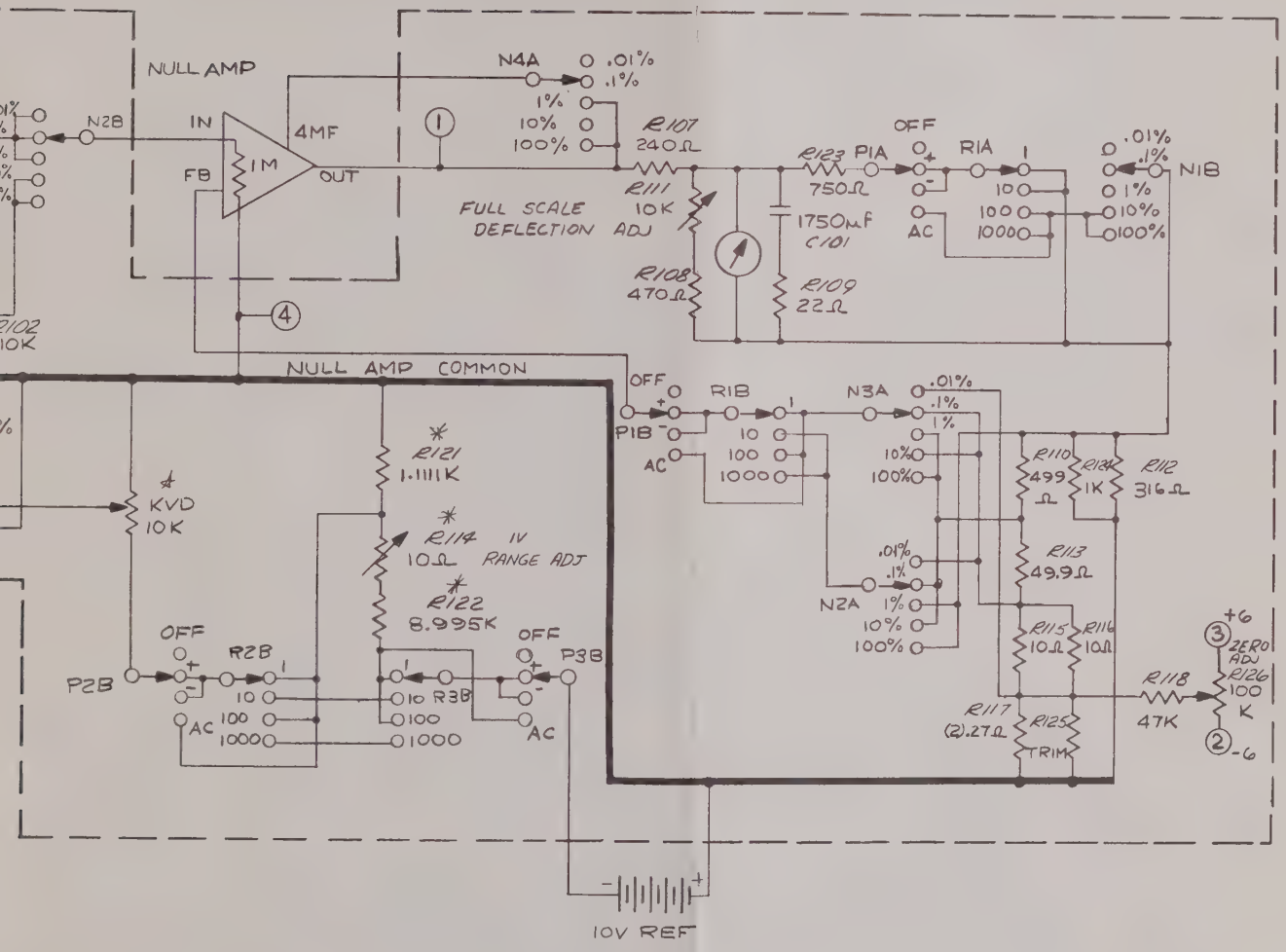
a: FIRST LETTER INDICATES SWITCH FUNCTION (N - NULL SENSI
R = RANGE SW102, P - POLARITY SW101)

b. NUMBER INDICATES WAFER LOCATION (1 IS WAFER CL
TO FRONT PANEL)

c SECOND LETTER INDICATES SWITCH POLE (A INDICATES L
AS VIEWED FROM FRONT)

4. * LOCATED ON BOARD 201-010A ONLY.

5. SCHEMATIC 200-200 B



tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
	WAVETEK san diego, calif				
scale N/A	by MEB	date 9-5-67	app. Pm		
material N/A	title SCHEMATIC- RANGE BD				
finish N/A	model no. 204	dwg no. 204-208	rev A		

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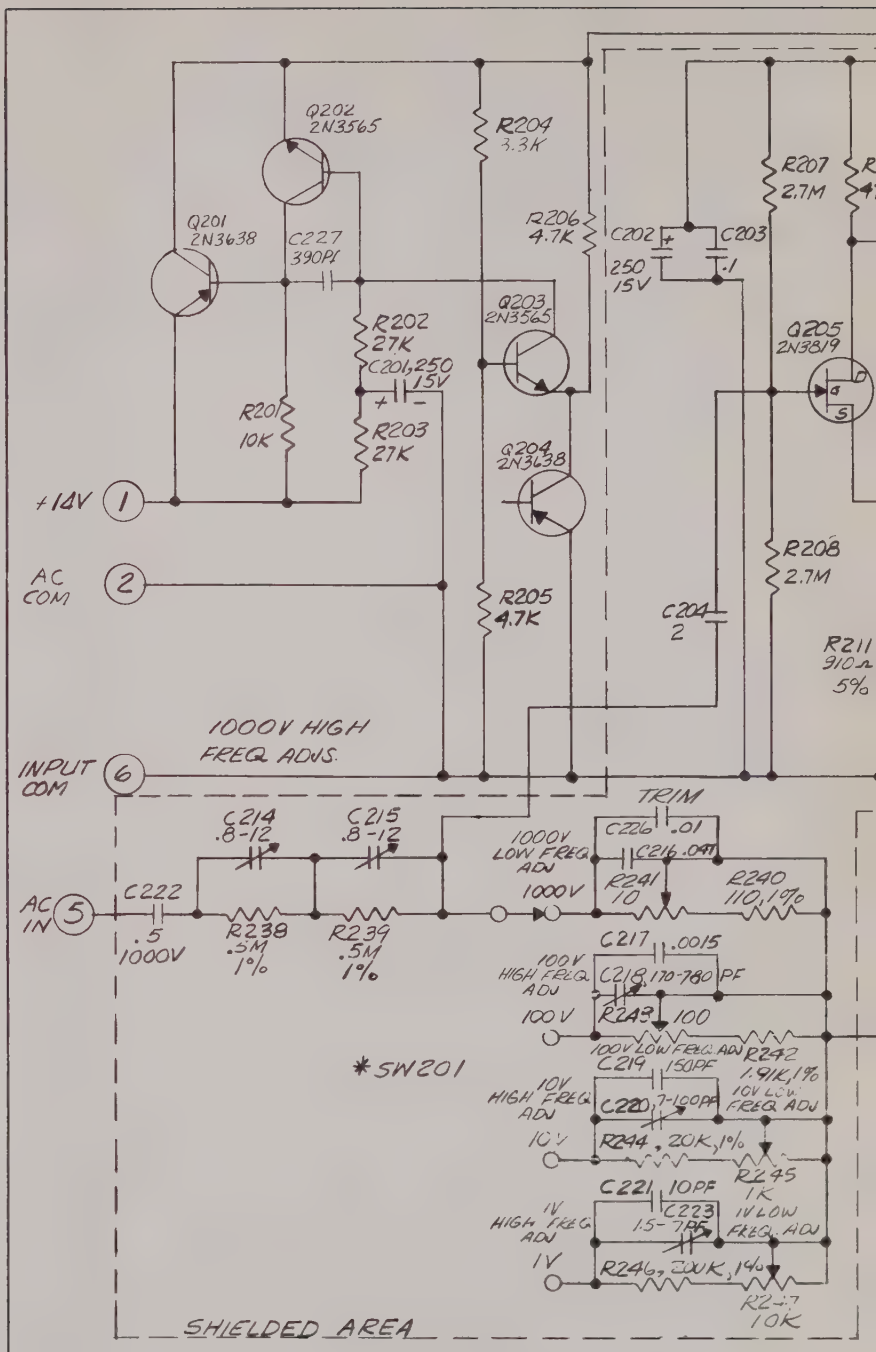
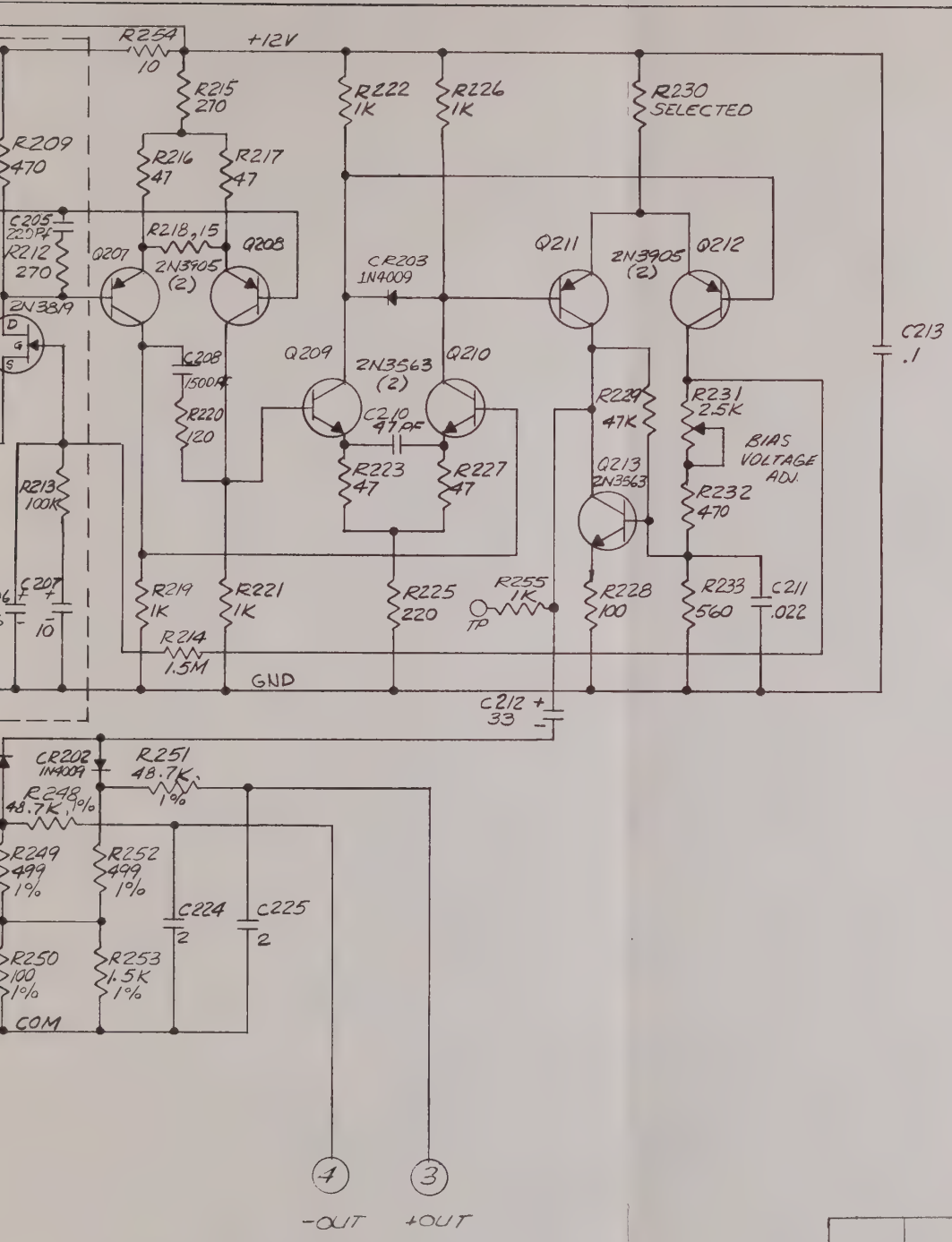
TY, SW103
ST
POLE



NOTE: UNLESS OTHERWISE SPECIFIED
1. RESISTANCE IN OHMS, 10%
2. CAPACITANCE IN MICROFARADS.
3. (*) GANGED WITH SWITCH SW102 ON RANGE BD.



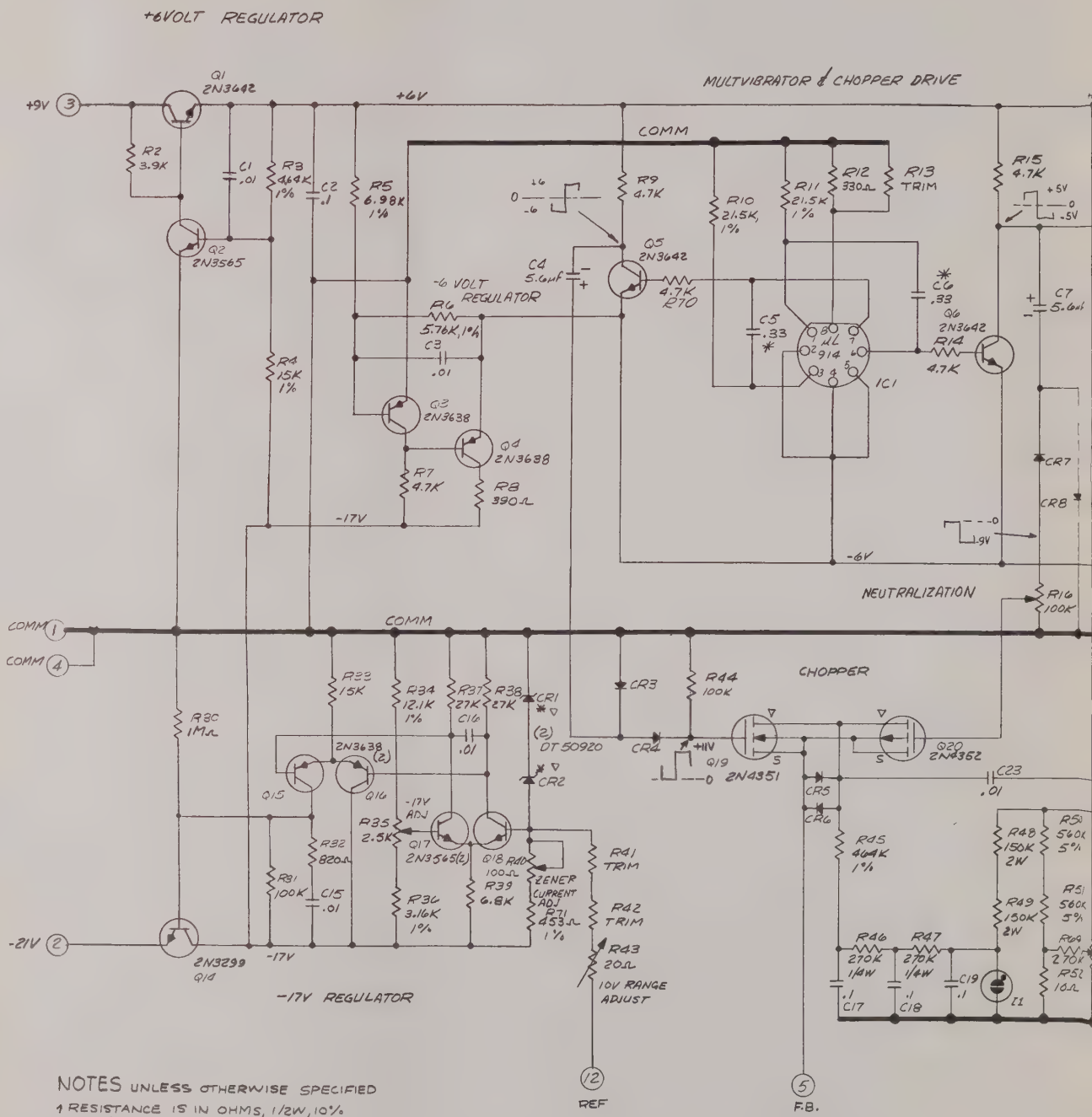
A	68:104	SLB	10-31-66	Pm
CHG.	ECN NO.	BY	DATE	APP

WAVETEK 8159 ENGINEER RD. SAN DIEGO, CALIF.

DWN: WHITELOCK DATE: 6-20-6 APP'D:

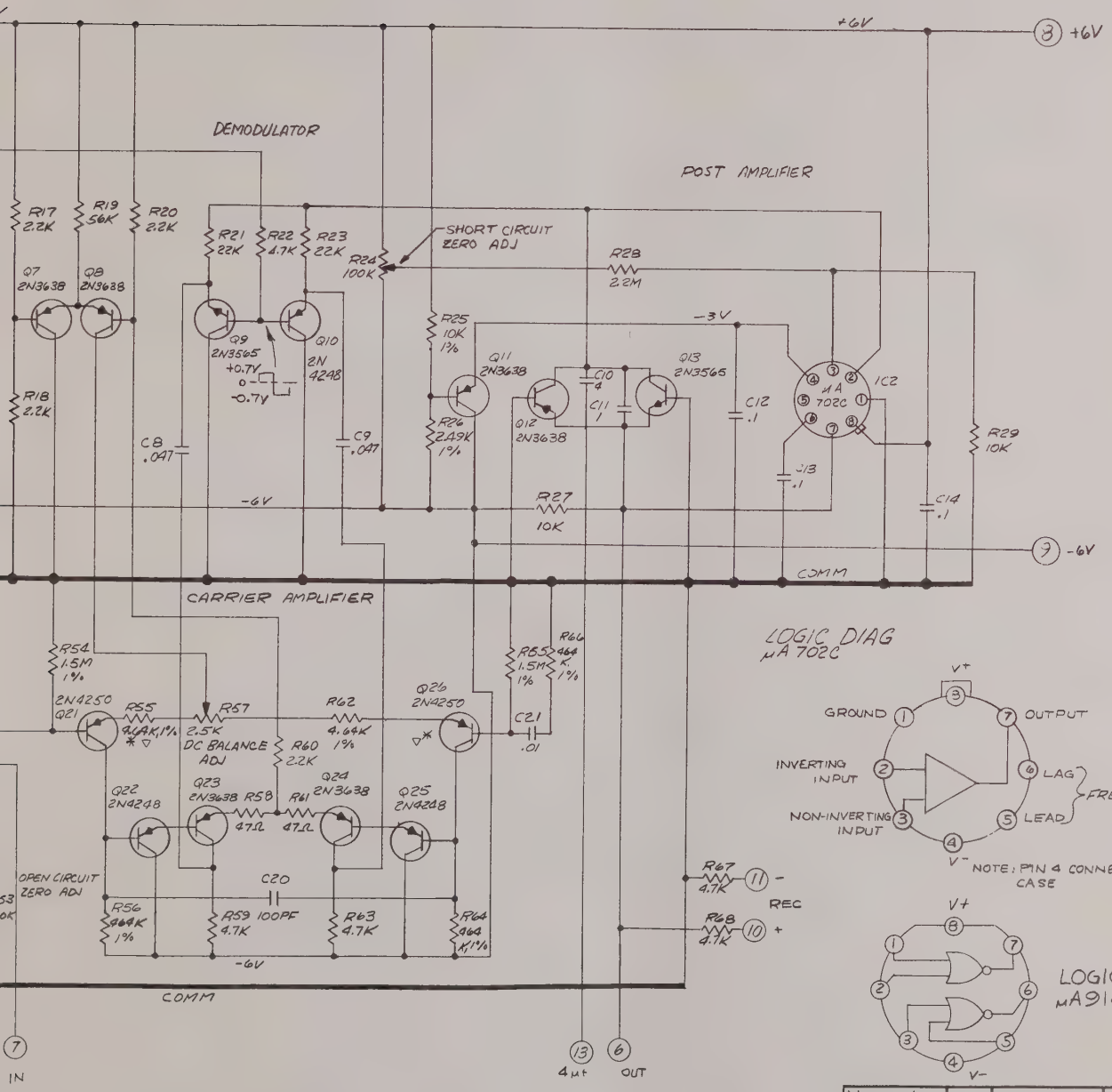
SCHEMATIC - AC CONVERTER BD

MODEL: 207, 202, 204 NO.: 202-204A



NOTES UNLESS OTHERWISE SPECIFIED

1 RESISTANCE IS IN OHMS, 1/2W, 10%
2 CAPACITANCE IS IN MICROFARADS
3 DIODES ARE FD6600
4 ✱ INDICATES MATCHED PAIR
5 ✱ INDICATES THERMALLY LINKED



COMPONENT DESIGNATOR

R71
C23
CR8
Q26
IC2

A	#181 #194	ENH	12-1-67		
REV	ECN	BY	DATE	APP	

tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date app.
	WAVETEK san diego, calif			
scale N/A	by M. E. Bo	date 7-10-67	app. Pat Marks	
material N/A	title SCHEMATIC— NULL AMPLIFIER B'D			
finish N/A	model no. 203, 204 207	dwg no. 203-202	rev A	

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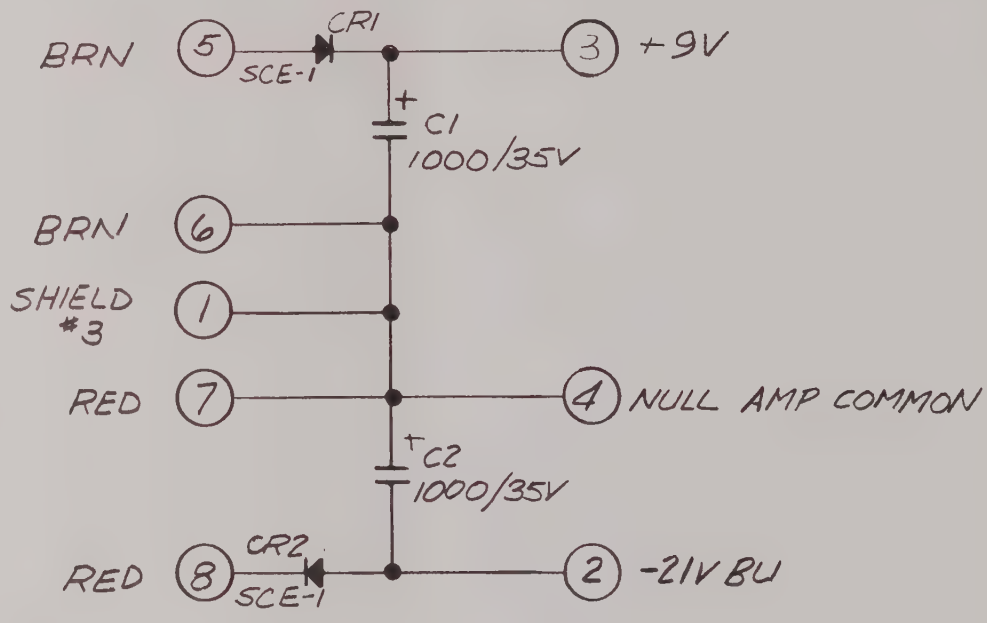
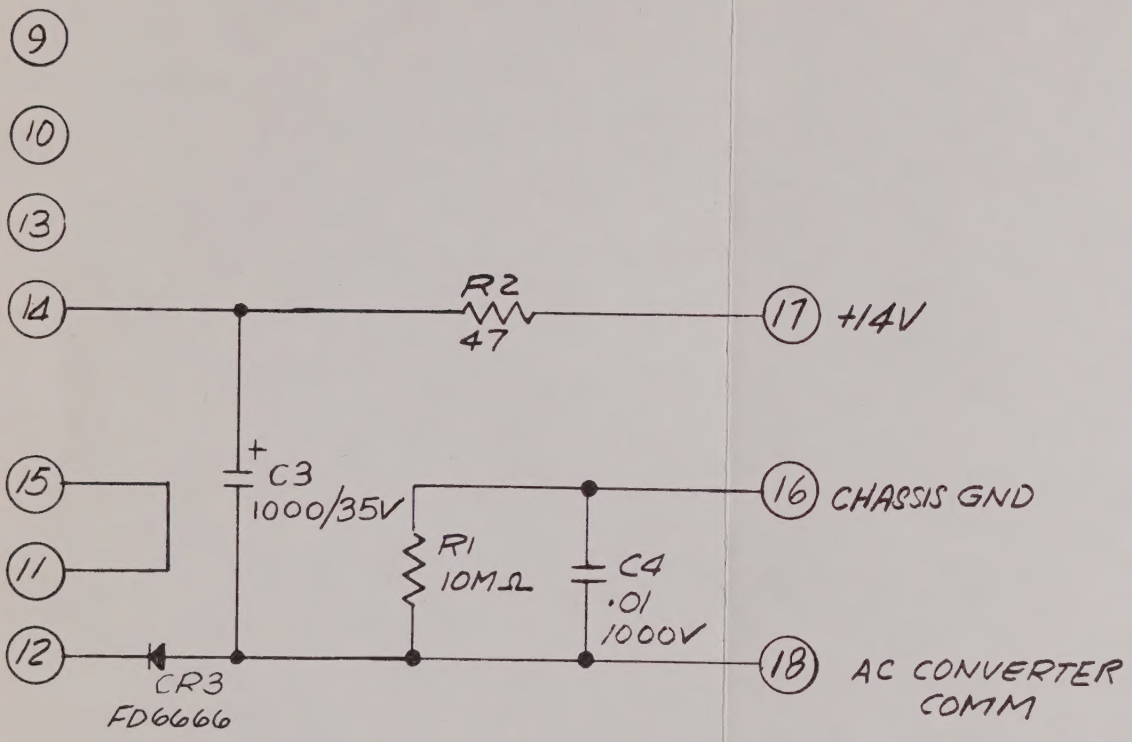


BRN
RED
GRN
BLU
VIO
ORN
YE

NOTES: UNLESS OTHERWISE SPECIFIED
1 RESISTANCE IS IN OHMS (Ω), 10%, 1/2W, CARBON
2. CAPACITANCE IS IN MICROFARADS



MODEL 202, 204 ONLY

tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
	WAVETEK san diego, calif				
scale N/A	by M Bochichio	date 9 29-67	app.		
material N/A	title SCHEMATIC- POWER SUPPLY				
finish N/A	model no. 201-204	dwg no. 201 - 204	rev		

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